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Gaseous and particulate emissions of a non-routine nature were measured in the exhausts of two light-duty Diesel-powered automobiles. These vehicles were a Mercedes 240D and a Volkswagen Rabbit Diesel. Visible exhaust smoke, regulated gaseous pollutants, and exhaust odor were also measured. Five fuels were used in this investigation, representing broad ranges in sulfur content, hydrocarbon-type composition, density, cetane index, and a number of other properties. Vehicle operating procedures used for test purposes included both those specified in Federal Regulations and several others simulating different driving situations. Gas samples were acquired from both direct and dilute exhaust streams. Particulate samples were taken using an exhaust dilution tunnel operating on the entire exhaust stream of each engine. Filter-collected particulate weights provided the basis for particulate mass emission calculations. The results of a statistical analysis of the particulate emissions data is included as is an analysis of gaseous emissions and particulate size data.

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July 1979

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ABSTRACT

Gaseous and particulate emissions of a non-routine nature were measured in the exhausts of two light-duty Diesel-powered automobiles. These vehicles were a Mercedes 240D and a Volkswagen Rabbit Diesel. Visible exhaust smoke, regulated gaseous pollutants, and exhaust odor were also measured. Five fuels were used in this investigation, representing broad ranges in sulfur content, hydrocarbon-type composition, density, cetane index, and a number of other properties.

Vehicle operating procedures used for test purposes included both those specified in Federal Regulations (FTP, FET)(1)* and several others simulating different situations (CFDS, NYCC, steady-state, odor test conditions). Gas samples were acquired from both direct and dilute exhaust streams. Particulate samples were taken using an exhaust dilution tunnel operating on the entire exhaust stream of each engine. Filter-collected particulate weights provided the basis for particulate mass emission calculations. Most of the sampling and analytical procedures used were developed during earlier EPA Contracts 68-02-1230(2,3), 68-03-2196 Task Order 4(4,5), and 68-02-1777(6).

A statistical analysis of the particulate emissions data was conducted, using some of the methods developed under Contract 68-02-1777(6). Analysis of gaseous emissions data and particulate size data was also conducted.

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[a] Superscript number in parentheses designate references at end of report

FOREWORD

This Final Report covers the entirety of EPA Contract No. 68-30-2440 conducted for the Emissions Control Technology Division, U.S. Environmental Protection Agency; 2565 Plymouth Road; Ann Arbor, Michigan 48105. The EPA Project Officer was Mr. Thomas M. Baines. Principal Investigator for Southwest Research Institute was Charles T. Hare, and overall supervision was provided by Karl J. Springer. The project was performed during the period August 1976 through May 1978, and it was identified within Southwest Research Institute as Project No. 11-4654.

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I. INTRODUCTION

Beginning with the 1975 model year, light-duty diesel-powered vehicles were brought under Federal exhaust emission standards(7). This action indicated that EPA considered it likely that U.S. sales volume of light-duty Diesels would soon become appreciable, due to concern over fuel economy and other factors. The advent of the Volkswagen and Oldsmobile Diesels within the past two years has shown the earlier EPA action to be very timely.

At present, light-duty Diesel gaseous exhaust emissions are regulated on the same basis as those of light-duty gasoline-powered vehicles. Diesel crankcase emissions and evaporative emissions are currently unregulated. Current and near-term future Federal regulations which apply to light-duty vehicles are summarized below:

Model year	Standards in g/mi			Standards in g/km			Corporate average fuel economy[b]	
	HC	CO	NO_x	HC	CO	NO_x	mi/gal	ℓ/100 km
1978	1.5	15.	2.0	0.93	9.3	1.2	18.	13.1
1979	1.5	15.	2.0	0.93	9.3	1.2	19.	12.4
1980	0.41	7.0	2.0	0.25	4.3	1.2	20.	11.8
1981	0.41	3.4[a]	1.0[a]	0.25	2.1	0.62	22.	10.7
1982	0.41	3.4[a]	1.0[a]	0.25	2.1	0.62	24.	9.8
1983	0.41	3.4	1.0[a]	0.25	2.1	0.62	26.	9.0
1984	0.41	3.4	1.0[a]	0.25	2.1	0.62	27.	8.7
1985	0.41	3.4	1.0	0.25	2.1	0.62	27.5	8.6

[a] waivers could apply to increase these limits (NO_x for Diesels, CO for gasoline vehicles), per Section 202 of the Clean Air Act

[b] administered by the U.S. Department of Transportation

Beginning with the 1981 model year, total particulate mass emission regulations are proposed for light-duty Diesel-powered vehicles(8). The proposed limits are 0.6 g/mi (0.37 g/km) for 1981 and 1982 vehicles, and 0.2 g/mi (0.12 g/km) for 1983 and later vehicles.

Of substances which are known to be emitted by Diesel engines in measurable amounts, some of those absent from current and known future light-duty regulations are solubles in particulate matter, visible smoke, odor, sulfate, and numerous other constituents of both exhaust gases and particulate matter. The project being reported on here was intended to broaden the available data base on (especially unregulated) emissions from light-duty Diesels, including effects of different fuels on emissions. At the time this project was performed, total particulate matter was also an unregulated pollutant.

A number of reasons exist to explain why unregulated pollutants have not been controlled, not all of which apply to each individual pollutant. These reasons include:

- readily observable short-term toxic, irritant, or nuisance effects not present;

- simp[illegible]asurement methods not available;

- definitive health effects studies and risk assessments not complete;

- data on association with hazardous or carcinogenic substances not available.

This project, as well as other current and recent work (6,9,10,11), is starting to provide data and measurement methods necessary to determine what additional pollutants from the Diesel, if any, need to be researched further or regulated by law.

II. SUMMARY AND CONCLUSIONS

The study detailed in this report was intended to provide information to EPA and the general public on both regulated and unregulated emissions from Diesel automobiles, and to describe as many fuel effects on these emissions as possible. These goals have been achieved, and information is also included on the influence of operating schedules on emissions. Data on mutagenic activity of extracts from Diesel particulate samples, developed by EPA's Research Triangle Park Laboratories, are presented and discussed for those samples derived from the test vehicles.

One of the major challenges overcome in performing this work was the integration of a number of sampling procedures into each test, thereby increasing the number of variables to be studied. Efficiency was achieved by minimizing wasted test repetitions which would have resulted from incorporating fewer sampling procedures into each test run. Separate tests were conducted for gaseous and particulate sample collection, however, since current practice (1977) did not specify simultaneous gaseous and particulate sampling. The test format was designed to provide the maximum amount of emissions characterization information using commercially-available fuels and a number of operating schedules, but the experimental design was not optimized for statistical analysis of fuel effects on emissions by regression techniques.

The most important observations and conclusions reached as a result of this project (not necessarily in order) are as follows:

1. Regulated gaseous emissions were not strongly affected by fuel composition, except for higher HC emissions from the VW Rabbit Diesel on EM-241-F ("minimum quality") No. 2 fuel during operating schedules containing substantial idle time. Regulated emissions were influenced somewhat more strongly by operating schedule. These results may not apply to other Diesel engines.

2. Aldehydes were measured by the DNPH procedure, which is yet to be fully qualified for Diesel engines. These data indicated that the VW emitted somewhat more aldehydes than the Mercedes, however, and that fuel effects were mixed. Substantial operating schedule effects on aldehydes were in evidence, with generally lower values for schedules involving low (or zero) speed variations.

3. Phenols were found in exhaust gases at higher mass rates than in particulate. The VW generally produced more phenols than the Mercedes, especially when "minimum quality" No. 2 fuel (EM-241-F) was used. Maximum phenol emission rates for both vehicles were under 32 mg/h, and para-cresol was found in more samples than any of the other compounds analyzed. The phenol procedure has not yet been fully qualified.

4. Analysis of trap-collected gaseous hydrocarbons showed higher boiling percentile temperatures than for corresponding fuels, as well as higher temperatures for samples taken during tests on No. 1 fuel than those for samples taken during tests on No. 2 fuels. This result, although based on very few observations, runs counter to expectations that gaseous hydrocarbons are closely related to fuel in composition.

5. Visible smoke from the test vehicles was generally very low except for a cold start peak and a few acceleration peaks. The VW also produced high "cold idle" smoke when EM-241-F "minimum quality" No. 2 fuel was used.

6. Particulate mass emissions from the Mercedes 240D were somewhat higher than those from the VW Rabbit Diesel, averaging about 29 percent greater by individual fuels, roughly in proportion to the difference in fuel consumed. Use of No. 1 fuel (EM-240-F) produced least particulate mass; and use of EM-241-F fuel produced greatest particulate mass, with results for the other three fuels grouped closely together between the extremes. Variation in operating schedules produced extremely large particulate mass emission variations (range up to 5:1) on a time basis (g/h), but much smaller variations (range up to 2:1) on a fuel specific basis (g/kg fuel). Average particulate mass emissions for "1975" FTP's were 0.329 g/km (4.59 g/kg fuel) for the Mercedes and 0.225 g/km (4.66 g/kg fuel) for the VW using EM-238-F 2D emissions test fuel. All particulate sampling was conducted with dilute exhaust temperatures of 52°C (125°F) or less at the filters.

7. Cyclohexane-soluble organics in particulate matter ranged from about 6 to 14 percent by weight over the five fuels for the Mercedes, and from about 12 to 16 percent by weight for the VW. Fuel and operating schedule effects on percent solubles were mixed.

8. Sulfur and sulfate in particulate matter were quite predictable over all fuels and operating schedules as linear functions of fuel sulfur, with r^2 values from 0.835 to 0.974. In all cases except sulfur emissions from the Mercedes, mass emission rates as averages by fuel were in the same relative rank order as fuel sulfur content. Sulfur in particulate matter, as a percentage of sulfur consumed in fuel, averaged about 1.9 percent for the Mercedes and 1.55 percent for the VW, with corresponding sulfur recoveries in sulfate of 1.65 and 1.95 percent, respectively.

9. As an average over all fuels and operating schedules, the VW emitted about 2.2 times as much benzo-a-pyrene (BaP) as the Mercedes on a fuel specific basis (about 19 μg/kg fuel versus about 9 μg/kg fuel). Highest average BaP was emitted by both vehicles when EM-241-F "minimum quality" fuel was used, and lowest BaP values were observed using EM-242-F "premium" No. 2 fuel. The Mercedes produced its highest BaP emissions during the idle and NYCC schedules (in decreasing order), while the VW produced its highest BaP during the cold FTP and NYCC schedules (in decreasing order).

10. Major elements by weight in organic solubles from particulate matter were carbon ($\sim$ 84 percent) and hydrogen ($\sim$ 12 percent), with small amounts of nitrogen and sulfur ($\sim$ 0.5 percent). Oxygen was also present at around 3 percent. These values are indicative of a predominantly hydrocarbon material with some impurities and substituted groups. The soluble organics did not contain visible soot.

11. Boiling ranges of soluble organics from particulate matter fell mostly between those of fuels and lubricating oils, but much closer to the oils. Their ranges include the boiling points of n-paraffins from about n-C_{16} (287°C) to above n-C_{56} (at 600°C), and a small fraction of the solubles boil at temperatures higher than the temperature limit of the procedure used for analysis (600°C).

12. Mutagenic activity of solubles from cold FTP particulate matter, as measured by the Ames bioassay, was higher for the VW than for the Mercedes by average factors of 2.2 to 1.7 (with and without metabolic activation, respectively). Samples from operation on EM-241-F "minimum quality" No. 2 fuel showed higher mutagenic activity (by factors of 3 or greater) than those from operation on other fuels, for both vehicles. Mutagenic activity correlated quite strongly (r values positive) with total particulate mass, BaP, and gaseous total hydrocarbons. Weaker correlations (r values negative) between mutagenic activity and percent solubles in particulate matter were also observed. These results must be considered preliminary due to the use of unqualified sampling and sample-handling procedures.

13. Except for rather obvious relationships between fuel variables and emissions variables (e.g., fuel sulfur and particulate sulfur), strong interrelationships between fuel variables (both pairwise correlations and multicollinearity) and small sample sizes generally made multiple linear regression analysis essentially useless in analyzing data from this study. Consequently, an approach using analysis of variance, multiple comparison of means across fuels and operating schedules, and listing of strongest pairwise correlators was adopted to describe relationships between emissions and fuel variables. This approach did not provide relationships predicting emissions as functions of fuel composition, but it did show directions for future work in the area of fuel effects. Some of these directions are (a) to maximize range and sample size of fuel variables, (b) to structure fuel composition toward minimizing fuel variable interrelationships, and (c) to minimize other sources of emissions variation (multiple vehicles, multiple operating schedules, etc.).

14. Emissions differences between vehicles and between operating schedules were generally stronger than those between fuels. While this situation helped make regression of emissions against fuel variables impossible, it did permit efforts toward identifying relationships between emissions and operating schedule variables. Regressions thus constructed for nine emissions variables (in time units) produced r^2 values from 0.588 to 0.945 (average 0.82), with schedule average speed as the dominant variable for all except BaP (speed variability dominant) and percent of particulate matter not analyzed as C, H, N, or S (percent idle time dominant).

15. Correlations between particulate mass rate and ambient variables (humidity, temperature, and atmospheric pressure) were negligible over the limited range of observed test conditions.

16. Particles, as sized aerodynamically by an inertial impactor were very small, with over 85 percent by weight classified as under 0.4 μm equivalent aerodynamic diameter. TEM micrographs, although probably operating on samples somewhat finer than were typical of total particulate matter, showed a numerical median agglomerate diameter of 0.045 μm and an estimated mass median agglomerate diameter of about 0.2 μm.

17. The major element in particulate matter collected was carbon (about 74 percent by weight for the Mercedes and 68 percent for the VW on cold FTP's), with hydrogen second most abundant of those measured at corresponding values of about 3 and 4 percent. Nitrogen in particulate matter was generally about 1 percent. These data are indicative of a primarily soot-like material with varying amounts of absorbed hydrocarbons. Idle operating conditions generally

produced comparatively low values for carbon and hydrogen, leaving a considerable amount of particulate mass unaccounted for by these elements. A substantial part of the unaccounted-for mass may have been oxygen, but oxygen measurements were not made.

III. TEST VEHICLES AND FUELS

Major criteria used for selection of test vehicles included availability, a difference between the two in engine and vehicle size, and fair representation of current market offerings. Fuel selection criteria were variety in specifications and a reasonable representation of the range of Diesel fuels available for automotive consumption.

A. Test Vehicles

The vehicles chosen for this program were a 1975 Mercedes 240D and a 1977 Volkswagen Rabbit Diesel. The Mercedes was a production unit, and the VW was a pre-production model with specifications the same as initial production vehicles. Descriptions of these vehicles are provided as Table 1. The cars were similar in basic engine design, type of transmission, and engine rated power per vehicle unit mass. Greater differences between the two were evident in compression ratio and engine displacement, both of which could affect emission of some exhaust constituents. For documentation purposes, the Mercedes 240D is shown in Figure 1, and the VW Rabbit Diesel is shown in Figure 2. Both vehicles were supplied to the Contractor by EPA for test purposes.

TABLE 1. DESCRIPTION OF TEST VEHICLES

Vehicle model	Mercedes 240D	VW Rabbit Diesel
Engine model (if different)	OM616	-----
Model year	1975	1977
V.I.N.	11511710066208	1763188714
Engine No. (if different)	616916-10-052895	-----
Body type	4 door sedan	2 door sedan
Loaded weight, kg (lb_m)[a]	1492 (3289)	1021 (2250)
Inertia equivalent, kg (lb_m)	1588 (3500)	1021 (2250)
Transmission	4 speed manual	4 speed manual
Displacement, ℓ (in^3)	2.40 (146.7)	1.47 (89.7)
Cylinders	4	4
Power, kW (hp) @ rpm	46.2 (62) @ 4350	35.8 (48) @ 5000
Injection system	Bosch	Bosch
Combustion chamber	prechamber	Swirl chamber
Compression ratio	21.0	23.5
Distance on vehicle, km[b]	6257	6176

[a] curb weight plus 136 kg (300 lb_m)

[b] at end of project

Figure 1. Mercedes 240D test vehicle

Figure 2. Volkswagen Rabbit Diesel test vehicle

B. Test Fuels

Four of the five required test fuels were specified in the Contract Scope of Work (included for reference as Appendix A) as follows:

- a No. 1 Diesel fuel;
- a No. 2 Diesel fuel representative of "national average" properties;
- a low-cetane (e.g. 42), high-aromatic Diesel fuel; and
- a high-cetane (e.g. 52), high-paraffin Diesel fuel.

It was decided early in the program that the specific fuel batches to be used in fulfillment of these requirements would be the corresponding fuels in use on another then-current EPA Contract, No. 68-02-1777(6). This decision was based on fuel availability, a desire to provide continuity in fuel specifications between the two programs, and the cost savings incurred by not having to run comprehensive analysis on additional fuels.

As an outgrowth of a meeting with the Project Officer, efforts were directed toward obtaining the fifth and last test fuel to be used for Task 3 testing. The decision was made that a "wide boiling range" or "100-650°F" fuel be secured from its source, understood to be Mr. W. T. Tierney of Texaco. As of that meeting, this fuel was visualized as having an approximately linear distillation curve throughout the temperature range.

Mr. Tierney was contacted, and his responding letter and attachment are included as Appendix B of this report. The most notable fuel characteristics determined by the computer run were the boiling range and the relatively low percentage of conventional Diesel fuel components. The fuel also contained relatively large amounts of olefins and naphthas. Figure 3 shows the boiling range of the computer-generated Texaco fuel as compared to those of: a gasoline; a No. 1 Diesel or "Jet A"; a range of two No. 2 Diesel fuels; a 40 percent - 40 percent - 20 percent blend of gasoline, No. 2 Diesel and No. 1 Diesel, respectively; an average JP-4 from 1974; and a blend supplied to EPA by Texaco as a "wide boiling fuel" before they (Texaco) had investigated the problem thoroughly.

The conclusion reached by examining Figure 3 was that the latest Texaco "wide-boiler" was unsuitable as a Diesel fuel. Mr. Tierney agreed (by telephone) that its cetane number would be around 30, and that the fuel was suitable only for direct-injection stratified-charge engines, (possibly) turbines, or external combustion engines. He also confirmed that the original blend supplied to EPA was a more conventional mixture of gasoline and Diesel fuel stocks. Thus, although a reasonable effort was made, the wide-boiling fuel did not prove to be a viable alternative for use in this project. It was recommended to the Project Officer that the fifth fuel for the testing phase of this project be designated as 2-D Emissions Test Fuel(8) without further delay. This recommendation was subsequently accepted when it became apparent that neither a suitable "wide boiling range" fuel nor any other usable synthetic fuel would become available in time for project use.

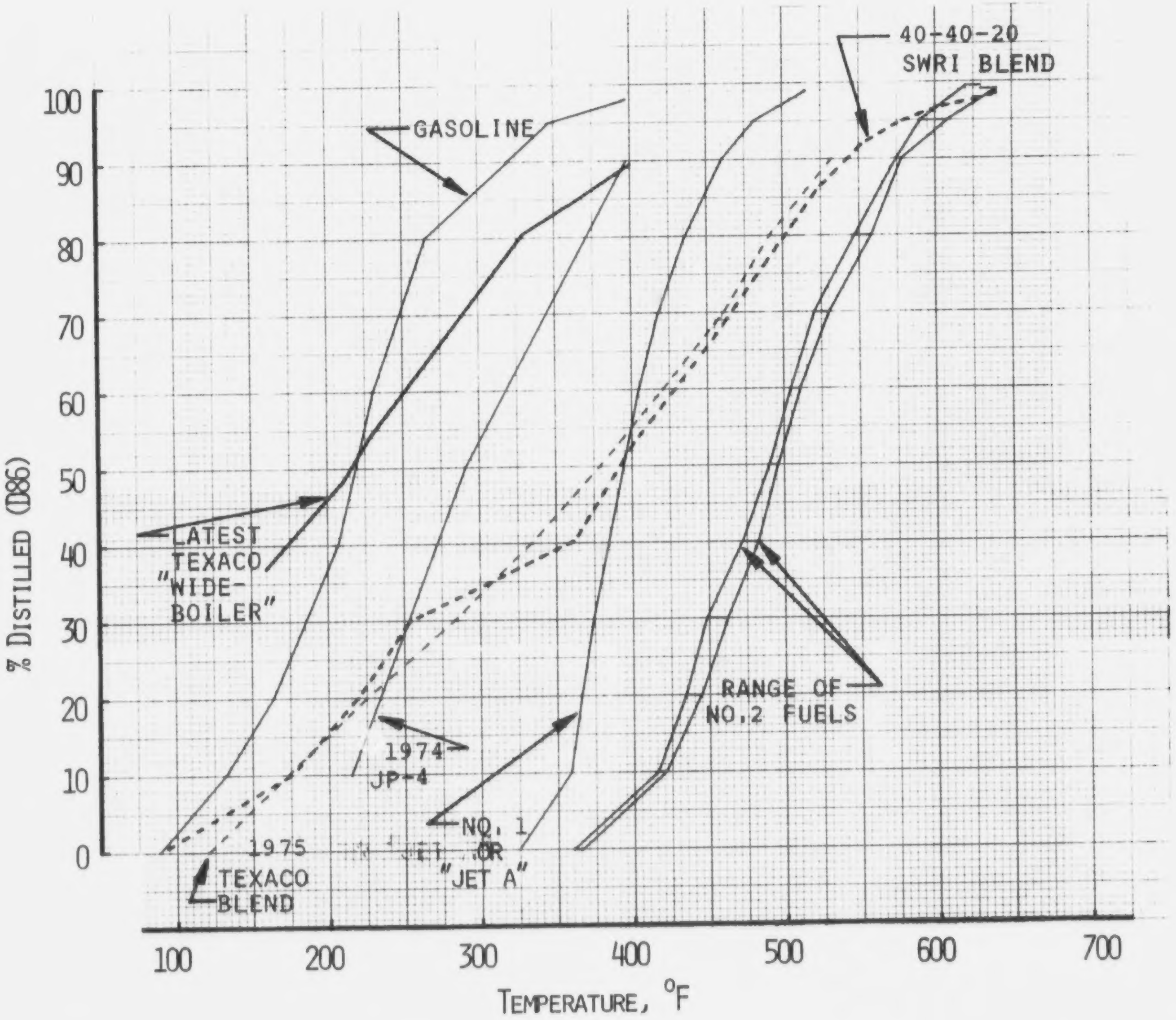

Figure 3. Boiling ranges of several fuels for comparison

The "2D emissions" test fuel was obtained from a local refiner, who blended it to Federal specifications(7). The "national average" No. 2 fuel was obtained locally because it just happened that a locally available No. 2 fuel was close to the "national average" specifications available. The "Jet A" No. 1 fuel was also obtained locally. Both "minimum quality" and "premium" fuels were obtained in drum lots through American Oil's Kansas City operations, because they routinely produced both types in that area. The "minimum quality" fuel contained a substantial amount of catalytically cracked stock or "cat gas oil", while the "premium" fuel was mostly "straight-run" refined West Texas crude. Table 2 contains values for all the major properties analyzed in the test fuels. For comparison, Table 3 shows "national average" No. 1 and No. 2 fuel properties from both 1973 and 1976 Bureau of Mines fuel surveys(12,13). Note that the Bureau of Mines fuel property data are not sales-weighted due to the unavailability of such information. Fuel nitrogen values are not considered extremely accurate due to lack of sensitivity of the method used for low nitrogen concentrations.

All boiling range data given in Tables 2 and 3 were obtained by ASTM D86 (thermal distillation) for best comparison purposes, although boiling range data used for statistical analysis (later in the report) were obtained by ASTM D2887-73 gas chromatograph-simulated distillation. Fuel coded EM-239-F was "doped" with ditertiary butyl disulfide to achieve the sulfur content listed in Table 2. When this fuel was obtained, it had a sulfur content of about 0.15 percent by weight. One of the major reasons for choosing this particular Gulf No. 2 fuel for the "national average" material (over other local fuels) was that its existing sulfur content was low enough to allow a stepwise blending approach to the target sulfur concentration of 0.23 percent.

Although fuel survey data for 1973 (published in 1974) were used as the basis in selecting a "national average" No. 2 fuel, data in Table 3 show that no major shifts in properties occurred between 1973 and 1976 fuels surveyed. In general, the more recent No. 2 fuels show slightly high density, sulfur, cetane, and boiling range. Comparing the No. 2 fuel survey results to EM-239-F shows no significant differences between the two. It was not intended that the No. 1 Diesel fuel chosen for this project (EM-240-F) be similar to the "national average" No. 1 Diesel fuel. It was intended that the No. 1 fuel used be at or near the low extremes of sulfur, density, and boiling range for fuels used in trucks and buses. Comparing specifications of EM-240-F of those of "national average" No. 1 fuels shows that this intent was met.

Comparing the five test fuels to each other shows that relatively large ranges of properties are present, as shown in Table 4. These ranges are expressed as percentages above and below property values for our "national average" No. 2 fuel coded EM-239-F. Ranges of individual 1976 Bureau of Mines fuel survey samples(13) are generally somewhat broader, but not significantly so considering percentages of fuels represented by outlying points and the proximity of some EM-239-F fuel properties to the value zero (e.g., fuel nitrogen and sulfur content). The skewed percentages resulting from this latter problem could have been avoided by defining ranges as "(equal) percentages above and below the mean of the extremes", but such a definition introduces the problem of unequal extremes (and consequent unequal means of said extremes) for test fuels as compared to fuel survey data.

TABLE 2. PROPERTIES OF THE FIVE TEST FUELS

Fuel Code	EM-238-F	EM-239-F	EM-240-F	EM-241-F	EM-242-F
Fuel Type	2D Emissions	National Average No. 2	"Jet A" No. 1	Minimum Quality No. 2	Premium No. 2
Properties					
Density, g/ml	0.845	0.844	0.806	0.861	0.831
Gravity, °API	36.0	36.1	44.1	32.8	38.7
Cetane, (D976)	48.6	48.7	47.4	41.8	53.0
Viscosity, cs (D445)	2.65	2.66	1.41	2.44	2.53
Flash point, °C	94	87	48	68	66
Sulfur, wt. % (D1266)	0.35	0.23	0.04	0.26	0.26
FIA: aromatics, %	29.8	21.6	13.0	34 6	12.4
olefins, %	1.6	0.8	3.4	1.0	0.8
saturates, %	68.6	77.6	83.6	64.4	86.8
Distillation (D86)					
IBP, °C	192	186	162	182	183
10% point, °C	213	216	181	216	213
20% point, °C	223	229	186	227	223
30% point, °c	233	239	190	240	231
40% point, °C	245	248	196	250	244
50% point, °C	257	257	201	258	254
60% point, °C	269	266	207	266	262
70% point, °C	281	275	214	277	271
80% point, °C	293	286	224	292	287
90% point, °C	213	303	238	301	301
95% point, °C	331	320	249	311	310
EP, °C	349	337	268	327	327
recovery, %	99	99	99	99.5	99
residue, %	1	1	1	0.5	1
loss, %	0	0	0	0.0	0
Carbon, wt. %[a]	86.8	86.8	86.2	87.5	86.3
Hydrogen, wt. %[a]	12.9	13.0	13.7	12.3	13.5
Nitrogen, wt. %[a]	0.005	0.005	0.006	0.024	0.008
Gum (D-481), mg/100 ml	9.9	8.6	0.2	11.8	2.2

[a] determined by combustion with automated thermal conductivity analysis-values not considered extremely accurate

TABLE 3. "NATIONAL AVERAGE"[a] PROPERTIES FROM FUEL SURVEYS

	1973 Fuel Survey(12)		1976 Fuel Survey(13)	
	No. 1 Fuel	No. 2 Fuel	No. 1 Fuel	No. 2 Fuel
Gravity, °API (ASTM D287)	41.4	36.4	42.2	35.7
Cetane (ASTM D613)	49.1	47.9	48.6	48.3
Sulfur, weight % (ASTM D129)	0.096	0.228	0.081	0.253
Distillation: IBP, °C	177	189	176	190
10% point, °C	199	219	196	221
50% point, °C	228	257	220	261
90% point, °C	263	302	252	307
EP, °C	284	327	274	333

[a] not sales-weighted

TABLE 4. RANGES IN PROPERTIES OF TEST AND SURVEY FUELS

Property	Range in Test Fuels, %[a]	Range in Individual 1976 Fuel Survey Samples, %[a]
Density, g/ml	+ 2.0, - 4.5	+ 6.7 , - 6.1
Cetane	+ 8.8, - 14.2	+ 34. , - 21.
Sulfur, wt %	+ 52. , - 83.	+ 500. , - 100.
Aromatics, vol. %	+ 60. , - 43.	---------------[b]
IBP, °K[c]	+ 1.3, - 5.2	+ 12. , - 6.9
50% point, °K	+ 0.2, - 11.	+ 6.5 , - 10.
EP, °K	+ 2.0, - 11.	+ 4.3 , - 16.
Carbon, wt. %	+ 0.8, - 0.7	---------------[b]
Hydrogen, wt. %	+ 5.4, - 5.4	---------------[b]
Nitrogen, wt. %	+ 480. , - 0.0	---------------[b]
Gum, mg/100 ml	+ 37. , - 98.	---------------[b]

[a] expressed as percentages above and below properties of EM-239-F

[b] no data

[c] note that percentages are based on absolute temperatures

IV. INSTRUMENTATION AND ANALYTICAL PROCEDURES

Collection and measurement of many gaseous and particulate constituents were required by the Contract Scope of Work, making necessary the use of a variety of sampling and analysis techniques. Descriptions of the equipment and procedures used are presented in a number of subsections for maximum clarity.

A. Simulation of Vehicle Road Operation

All laboratory vehicle operation except that for odor (and concurrent emissions) measurement was performed on a 2-roll Model ECE-50 Clayton light-duty chassis dynamometer of the type qualified for Federal light-duty certification(14). The Mercedes 240D was set up to drive the dynamometer via its rear wheels, while the VW Rabbit Diesel drove the rolls with its front wheels. Accommodating the two types of drive trains required adjustments in equipment positions, but created no real difficulty. The dynamometer described is shown in Figure 4. Inertia and power absorption settings used for all test work on this dynamometer followed EPA guidelines(14).

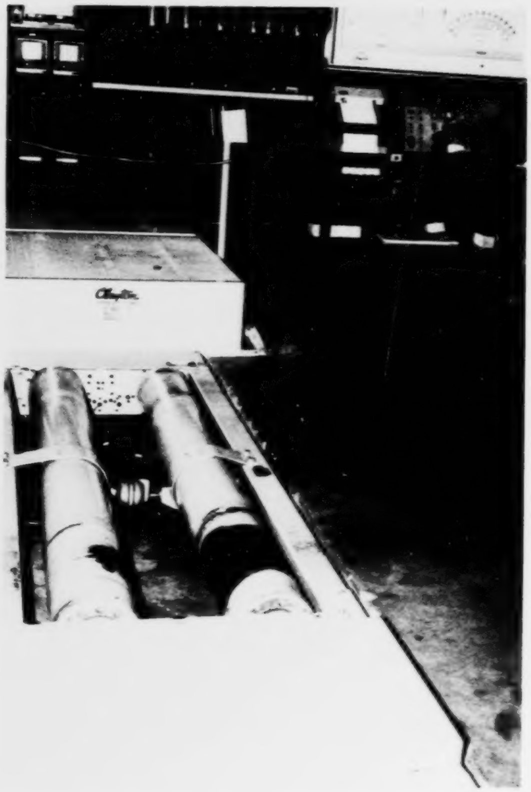

Figure 4. Light-duty vehicle chassis dynamometer used for all testing except that involving exhaust odor evaluations

Vehicle operation for exhaust odor evaluation and concurrent emission measurements was conducted on another chassis dynamometer, this one designed primarily for operation of heavy-duty vehicles, but adaptable to light-duty testing under steady-state and simple transient conditions. This tandem-axle dynamometer is a Clayton Model CT-200-200, with only the rear pair of rolls driven in this application. The four "transient" conditions simulated for odor evaluation by human panel were a cold start, an idle-acceleration, an acceleration, and a deceleration. Only the last three transients listed actually involved simulated vehicle motion against inertia, so they were the only odor conditions for which flywheel inertia simulation came into play. Inertia wheels available for the heavy-duty dynamometer were spaced in rather coarse increments, and the closest one to actual inertia of the VW Rabbit Diesel was 1270 kg. The simulated inertia used for the Mercedes 240D was correct at 1588 kg. Figure 5 documents the appearance of the dynamometer used for odor work.

Figure 5. Chassis dynamometer used for tests involving odor evaluations

B. Visible Smoke Measurements

Exhaust smoke from both vehicles was measured using an optical light-extinction smokemeter of the type specified in Federal regulations for heavy-duty Diesel engine smoke certification(14). The smokemeter was mounted on a 51 mm (2 in) O.D. tailpipe extension when in use, as shown in Figure 6 (Mercedes 240D) and Figure 7 (VW Rabbit Diesel). The control/readout unit for the smokemeter was mounted remote from the vehicle under test, and continuous recordings of smoke opacity were made concurrently with vehicle speed traces. Smoke measurements were made over the first 505 seconds (the transient phase) of both cold-start and hot-start FTP cycles while the vehicles were operated

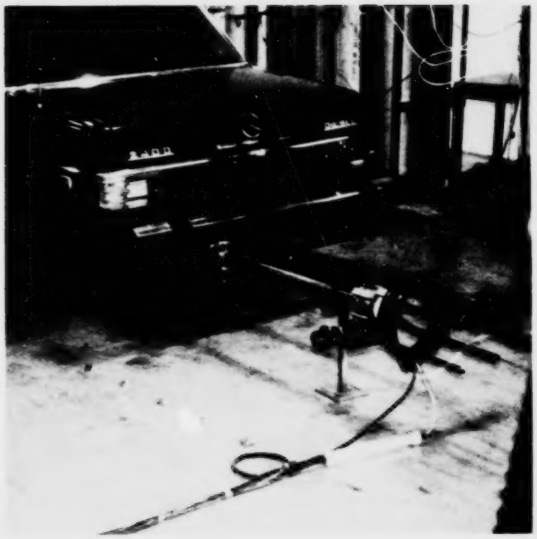

Figure 6. Smokemeter mounted on Mercedes 240D

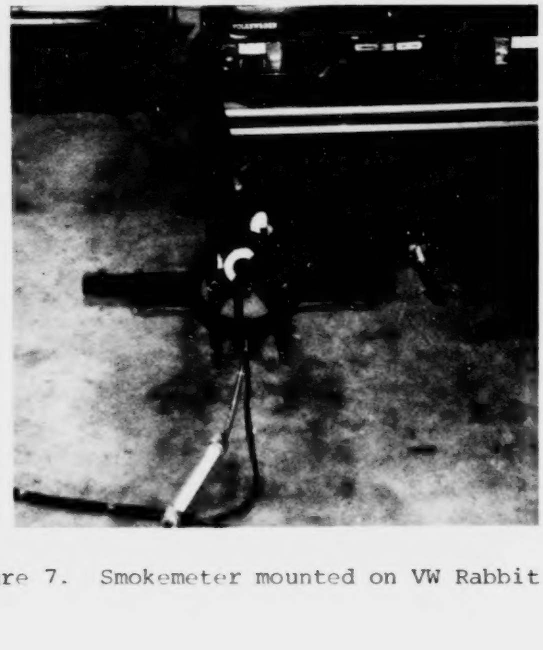

Figure 7. Smokemeter mounted on VW Rabbit Diesel

on a chassis dynamometer. This procedure is not part of any known smoke regulation, but was developed for research purposes on an earlier EPA Contract, No. 68-03-2417(10).

C. Routine Gaseous Emissions Measurements

Regulated gaseous emissions (HC, CO, and NO_x) from the test vehicles were evaluated using CVS (constant-volume sampler) exhaust dilution, bag sampling for CO and NO_x, and subsequent measurement of diluted exhaust (bag) concentrations using a bank of continuous analyzers. The analyzers included NDIR instruments for CO and CO_2, and a chemiluminescence unit for NO_x, as shown in Figure 8. Hydrocarbon measurements were conducted using continuous heated FID (flame ionization detector) with electronic signal integration to provide average dilute hydrocarbon concentration for each run. A continuous trace of dilute HC concentration was also obtained via a chart recorder. This equipment is shown in Figure 9. These measurements followed EPA practice for Federal emissions certification of light-duty Diesel vehicles(7). The vehicles were operated on a light-duty chassis dynamometer during the several driving schedules required.

D. Measurement of Non-Routine Gaseous Emissions

This group of analyses includes those for low molecular weight aldehydes and for gaseous hydrocarbons collected on Chromosorb 102 traps. Since the primary object of the phenol analysis was to determine phenols in particulate matter, the equipment and technique used will be discussed under the "Particulate Compositions" subhead (Section 4.H.).

Aldehydes were measured in dilute exhaust samples with processing by the DNPH (Dinitrophenylhydrazone) method(15). The collection system used is shown schematically in Figure 10, and it was operated at a sample flow rate of 0.24 m^3/h at relatively constant laboratory ambient conditions. This type of operation provided a proportional sample for both transient and steady-state vehicle operation, yielding accurate integrated rates for each test. Following several labor-intensive processing steps, a small portion of each sample was injected into a Varian 1740 chromatograph-FID for analysis. The GC was equipped with a 3.2 mm (diameter) by 610 mm (length) stainless steel column, packed with 6.7 percent Dexsil 300 on 60/80 mesh Chromosorb G, and programmed from 130°C to 300°C at 8°C per minute. A permanent record of the GC output was obtained using a strip chart recorder, and quantitative data were obtained using a remotely-located Hewlett-Packard 3354 computer tied in via an analog-to-digital converter. A copy of the analysis procedure is given in Appendix C, page C-2.

Gaseous hydrocarbons in Diesel exhaust were collected on Chromosorb 102 cartridges by sampling diluted, filtered exhaust through them. The collection apparatus is shown schematically in Figure 11. It should be noted that although diluted exhaust had a maximum temperature of 52°C, the sample was subsequently heated to 190°C prior to filtration and pumping. Maximum temperature in the sampling cartridges themselves was 100°C. Sample flow through the system was maintained at a constant rate of about 0.24 m^3/h. Cartridges were capped immediately after sampling, and their contents were subsequently eluted with carbon disulfide (CS_2) to remove trapped hydrocarbons. Boiling range of the hydrocarbons was determined by a gas chromatograph equipped with

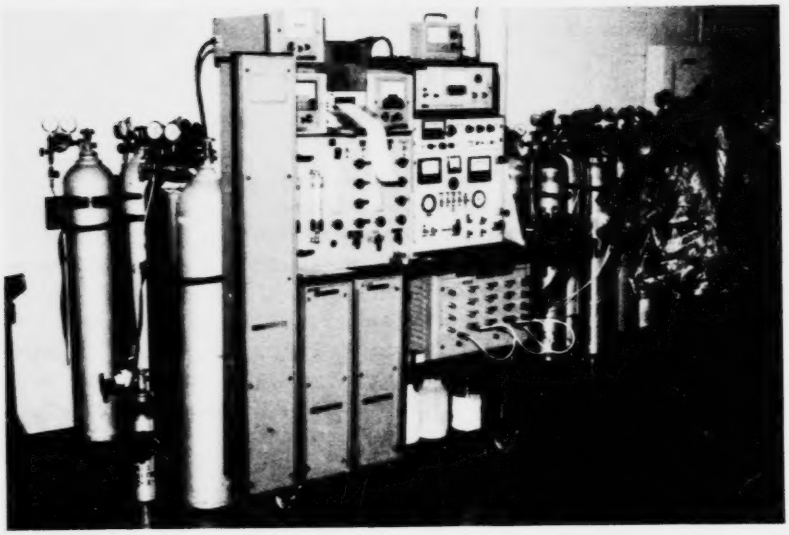

Figure 8. Dilute exhaust analysis system

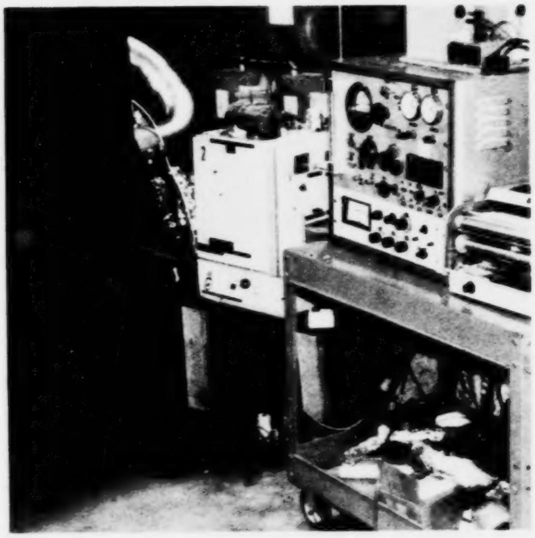

Figure 9. Continuous dilute hydrocarbon analysis/integration system

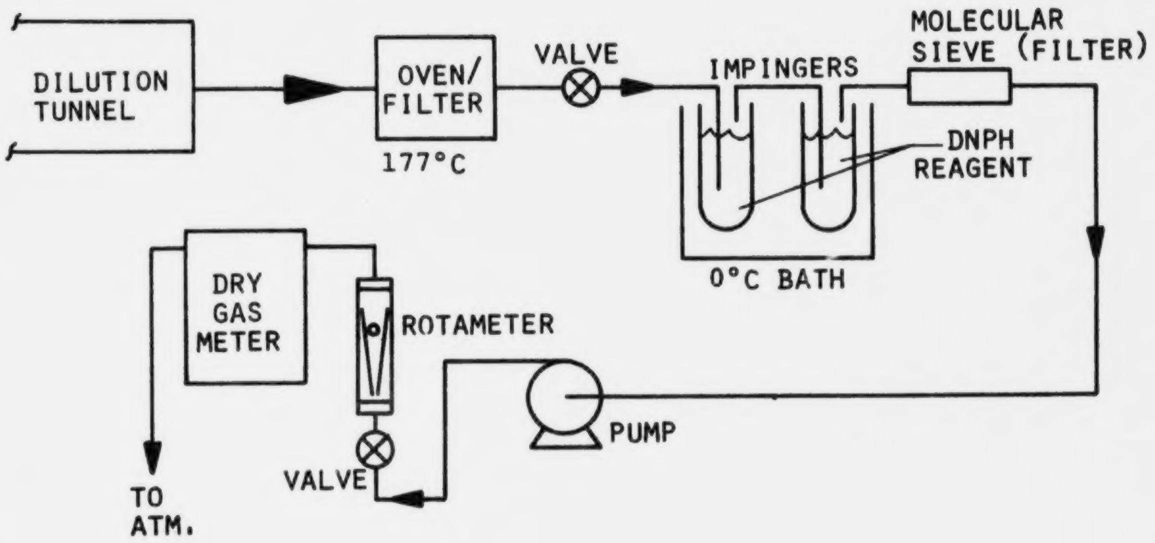
DILUTION
TUNNEL
OVEN/
FILTER
177°C
VALVE
IMPINGERS
MOLECULAR
SIEVE (FILTER)
DNPH
REAGENT
0°C BATH
DRY
GAS
METER
ROTAMETER
PUMP
VALVE
TO
ATM.

Figure 10. Schematic diagram of aldehyde sampling system

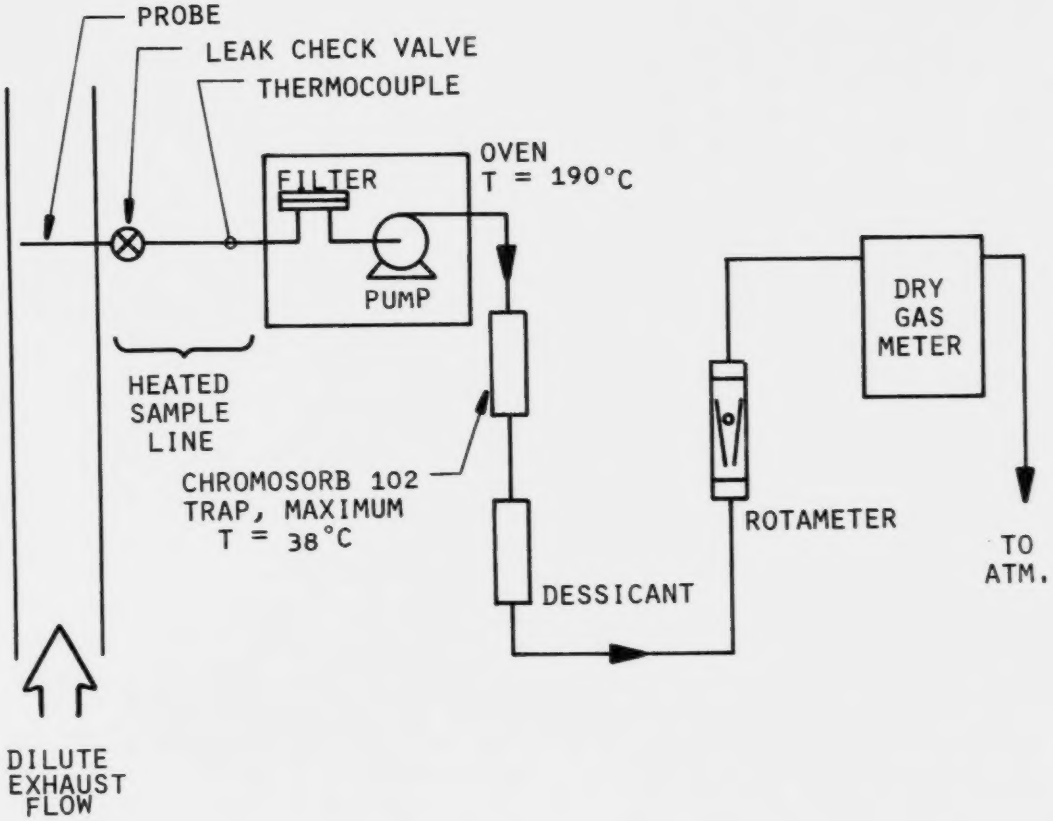
PROBE
LEAK CHECK VALVE
THERMOCOUPLE
OVEN
T = 190°C
FILTER
PUMP
HEATED SAMPLE LINE
CHROMOSORB 102 TRAP, MAXIMUM T = 38°C
DESSICANT
ROTAMETER
DRY GAS METER
TO ATM.
DILUTE EXHAUST FLOW

Figure 11. Schematic diagram of gaseous HC sampling system (for boiling range analysis)

dual hydrogen flame ionization detectors. The column was 1.8 m (length) by 3.2 mm (diameter) stainless steel, packed with 5 percent SE-30 on 80/100 mesh Chromosorb G, AW-DMCS. It was programmed from 0°C to 390°C at 16°C per minute, and maintained a detector temperature of 400°C. Carrier gas flow was 25 mℓ helium per minute. Data processing was conducted on a Hewlett-Packard 3354 computer system.

E. Evaluation of Exhaust Odor

Exhaust odor of the test vehicles was evaluated in 100:1 air-diluted samples by a trained human panel, and a concurrent raw exhaust sample was taken during each steady-state odor run for later analysis by the A. D. Little "Diesel Odorant Analytical System" (DOAS). The vehicles were operated on the heavy-duty chassis dynamometer described in Section 4.A. under steady-state and simple transient conditions. Exhaust sampling, dilution, and presentation facilities for odor evaluation by the human panel have been thoroughly described in earlier publications(16). In brief, a small amount of vehicle exhaust was mixed at constant dilution with filtered, humidity-controlled, and temperature-controlled air before presentation to the panel. The vehicle operator signaled the panel when they were to sniff the dilute mixture, and each panel member independently rated the odor as to intensity and character. These ratings were made in terms of a 12-step overall odor intensity scale (0-12) and four character or "odor quality" scales having four steps each (0-4). The quality scales were termed "burnt-smoky", "oily", "aromatic", and "pungent".

The DOAS(17) used essentially the same sampling system shown in Figure 11, except that sampling was directly from raw exhaust rather than the dilution tunnel. Samples were taken for about 5 minutes onto the Chromosorb 102 traps, and then analyzed by the DOAS liquid column instrument. The output was in the form of LCO (liquid column oxygenate) and LCA (liquid column aldehyde) values. The LCO values were related to odor prediction by the relationship: TIA (total intensity of aroma = 1 + $\log_{10}$ LCO). A. D. Little's DOAS analyzer is shown in Figure 12, and Figure 13 shows traps in sampling position on the oven during an odor measurement run.

In addition to direct odor evaluation by two techniques, several other exhaust composition measurements were made during the steady-state odor tests. These measurements included conventional gaseous emissions (HC, CO, NO_x, CO_2), aldehydes, and individual hydrocarbons in raw exhaust. Gaseous emissions were measured with the equipment shown in Figure 14 (HC analyzer) and Figure 15 (CO, CO_2, NO_x analyzers). Aldehydes were measured by collection in aqueous reagents and analyzed as previously described in Section 4.D. Individual hydrocarbon samples were collected in bags and analyzed by an EPA-developed gas chromatograph procedure(18).

F. Particulate Mass Rate, Concentration, and Aerodynamic Sizing

Particulate collection for this project was performed using a 457 mm (18 inch) diameter dilution tunnel operating on total vehicle exhaust, probes and other equipment to withdraw samples from the tunnel and collect the particulate on filters, and a balance to determine mass of particulate matter collected. The dilution tunnel used is shown schematically in Figure 16, along with some of its pertinent dimensions and attached equipment. This

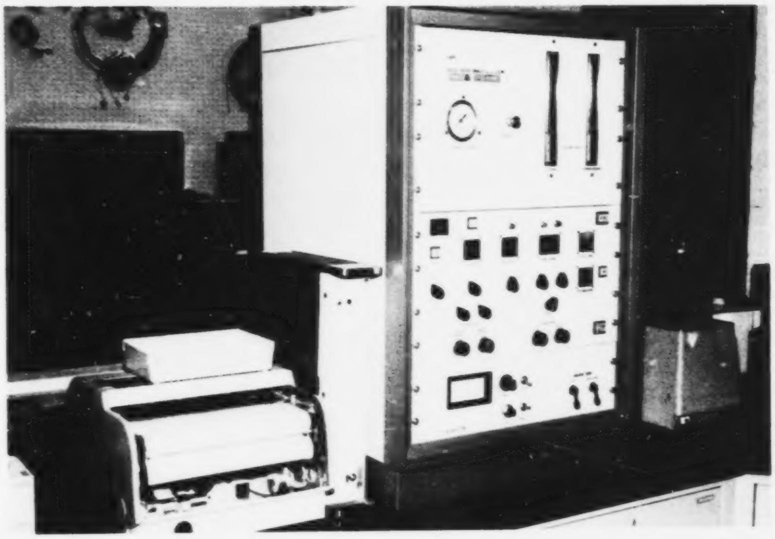

Figure 12. A.D. Little DOAS analyzer

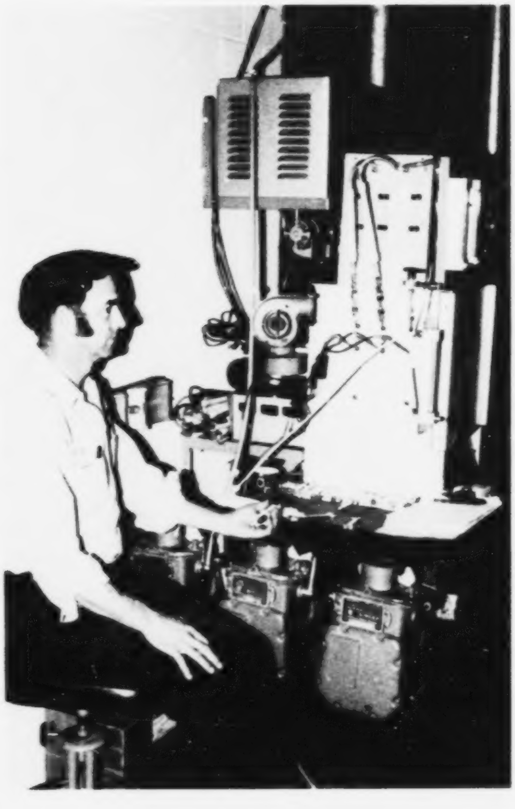

Figure 13. Chromosorb 102 traps being loaded for DOAS analysis

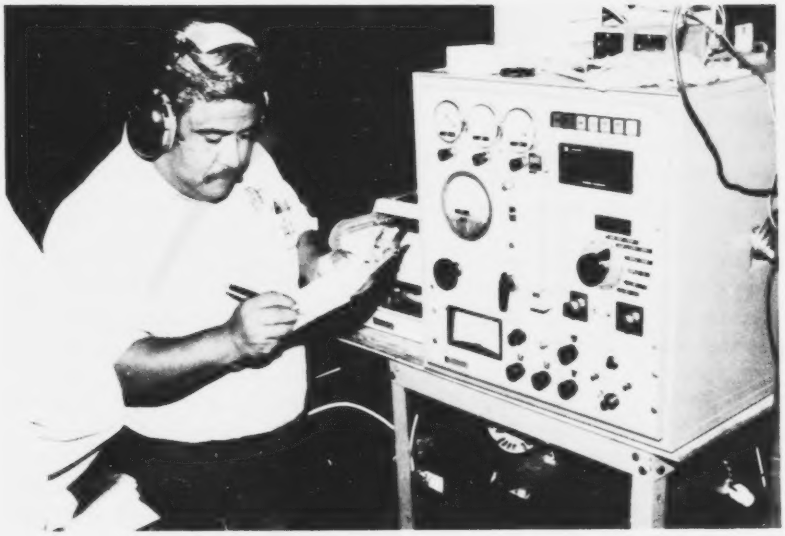

Figure 14. Continuous hydrocarbon analyzer for raw exhaust

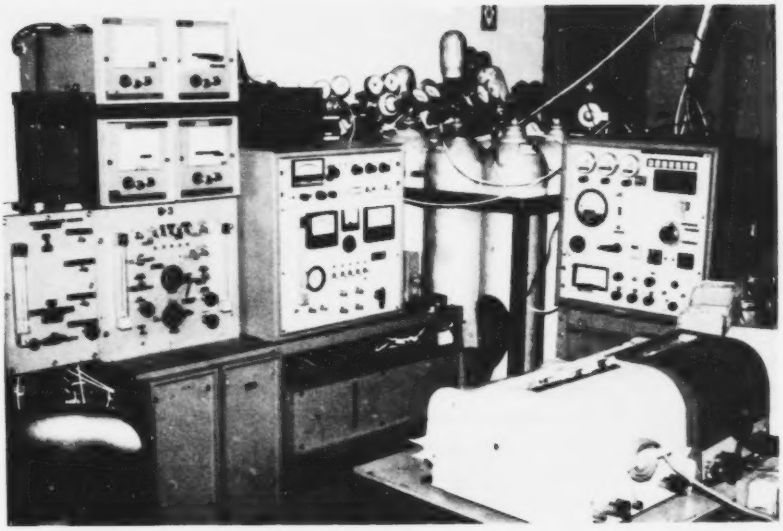

Figure 15. Continuous CO, CO_2, and NO_x analyzers for raw exhaust

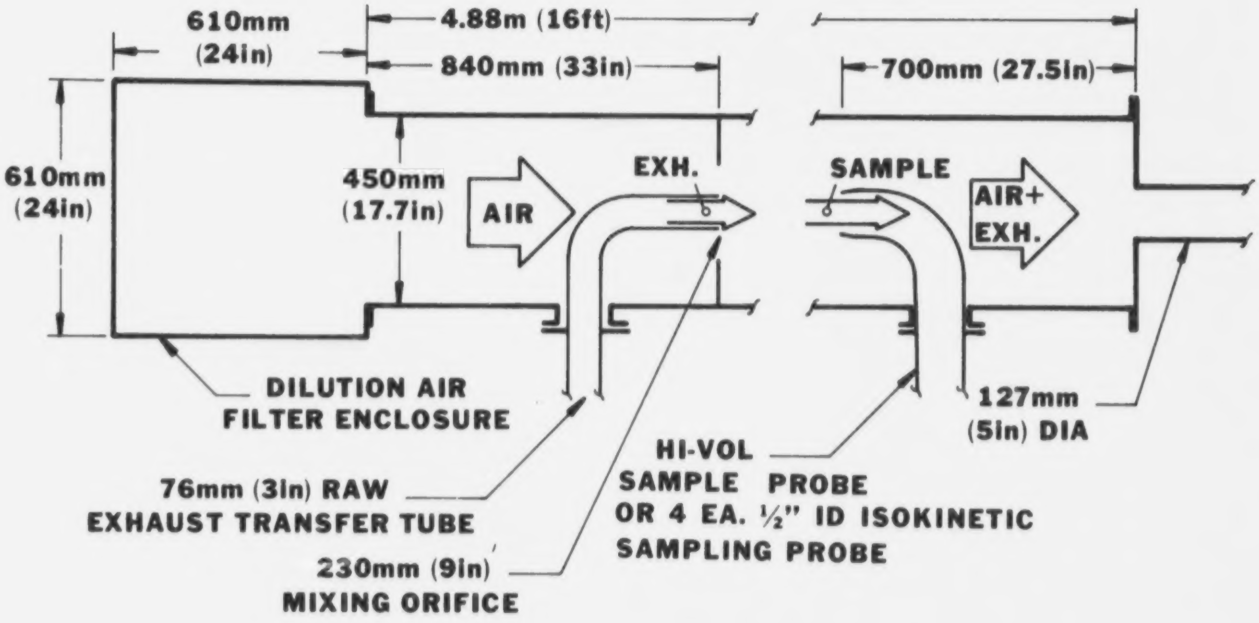
610mm
(24in)
4.88m (16ft)
840mm (33in)
700mm (27.5in)
610mm
(24in)
450mm
(17.7in)
AIR
EXH.
SAMPLE
AIR+
EXH.
DILUTION AIR
FILTER ENCLOSURE
76mm (3in) RAW
EXHAUST TRANSFER TUBE
230mm (9in)
MIXING ORIFICE
HI-VOL
SAMPLE PROBE
OR 4 EA. ½" ID ISOKINETIC
SAMPLING PROBE
127mm
(5in) DIA

Figure 16. Schematic diagram of exhaust dilution tunnel

tunnel design, which follows earlier ones by Habibi(19) and EPA(20,21), is one of many which are in use or have been suggested for sampling particulate matter emitted by vehicles having Diesel engines. A number of the details of adaptation of this tunnel to light-duty Diesel particulate research were worked out during previous EPA contracts(9,11). Some of the equipment necessary for collecting particulate and relating it to undiluted vehicle emissions is not shown in the schematic. It includes a positive-displacement pump operating at about 500 m^3/h to withdraw and measure unsampled air/exhaust mixture, and sampling systems with filter holders, pumps, rate flowmeters, and flow totalizing devices.

Figures 17 and 18 show the dilution tunnel as set up with the Mercedes and VW vehicles, respectively. In both cases, the vehicle's exhaust entered the tunnel horizontally near the upstream end, and sampling took place near the downstream end. A special sample probe/filter holder assembly was designed and constructed for this project to minimize repetitive test runs. The portion of this assembly which protruded from the tunnel (filter holders, etc.) is shown in Figure 19, and the remainder is shown in Figure 20. Four probes to intercept samples for 47 mm filters and one probe to catch sample for the inertial impactor were nested inside the hi-vol probe. This design permitted taking the six samples simultaneously, while keeping the size of the entry port into the tunnel at a minimum.

Two of the 47 mm filter holders were modified to accept Viton-A o-rings, necessary for use with Fluoropore* filters in order to reduce leakage around the filter when placed under vacuum. The other two 47 mm holders were used with glass fiber filters, and the hi-vol or "8 x 10" filter was also glass fiber. Teflon-coated glass fiber filters were not in widespread use when this project was conducted. The glass fiber filters were held between stainless steel flats in the 47 mm holders, but the hi-vol holder used a foam gasket on one side with stainless on the other. An inertial particle-sizing impactor was used as the sixth collection device, mounted on the probe having the largest tip diameter of the five nested inside the hi-vol probe. Its tip was of 16.6 mm inside diameter, while those connected to 47 mm filter holders were 12.7 mm inside diameter. The hi-vol probe tip had an inside diameter of 97.3 mm.

The four 47 mm systems and the impactor system were all connected to pumps, rotameters with flow control valves, and dry gas meters downstream of the filter holders. The hi-vol system incorporated a blower just downstream of the filter holder, and a calibrated orifice was located further downstream following a straight tube section. The impactor system contained collection discs on which particulate matter was supposedly fractionated by size, and a final glass fiber backup filter. The impactor system is shown disassembled in Figure 21, with the plates, gaskets, and crossbars removed from their holder for clarity. The stainless discs and typical filters are shown before use (new) in Figure 22, and after use in Figure 23. In operation, one stainless disc was placed on each stainless impactor plate from No. 1 through No. 8, and the glass fiber filter was located on the filter backing plate. The discs were photochemically machined of 0.05 mm stainless steel to provide a low-tare weight collection medium (about 900 mg) having particle

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* registered trademark Millipore Corporation

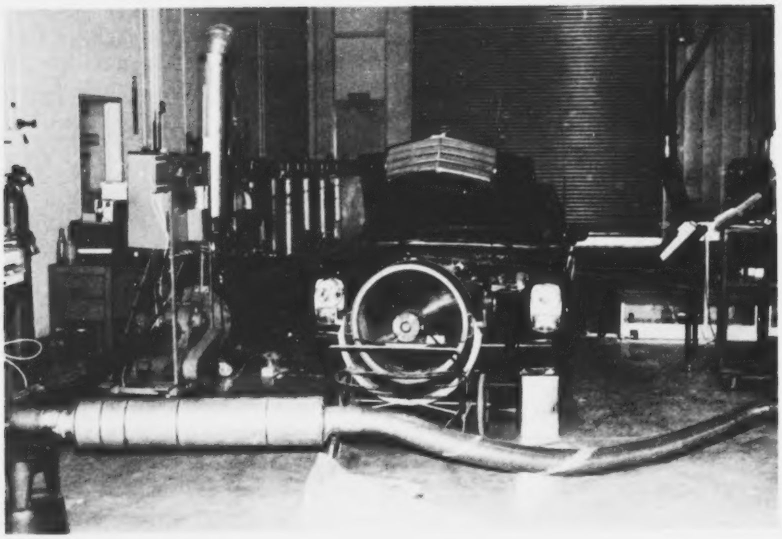

Figure 17. Mercedes 240D operating with particulate dilution tunnel

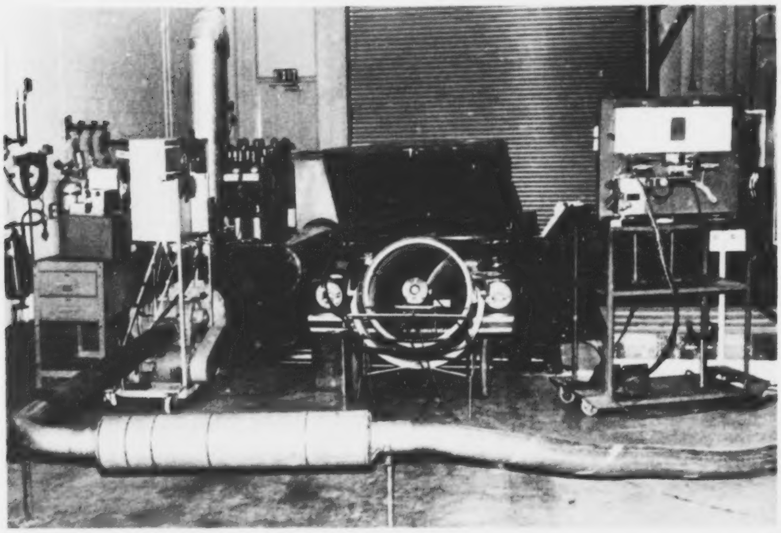

Figure 18. VW Rabbit Diesel operating with particulate dilution tunnel

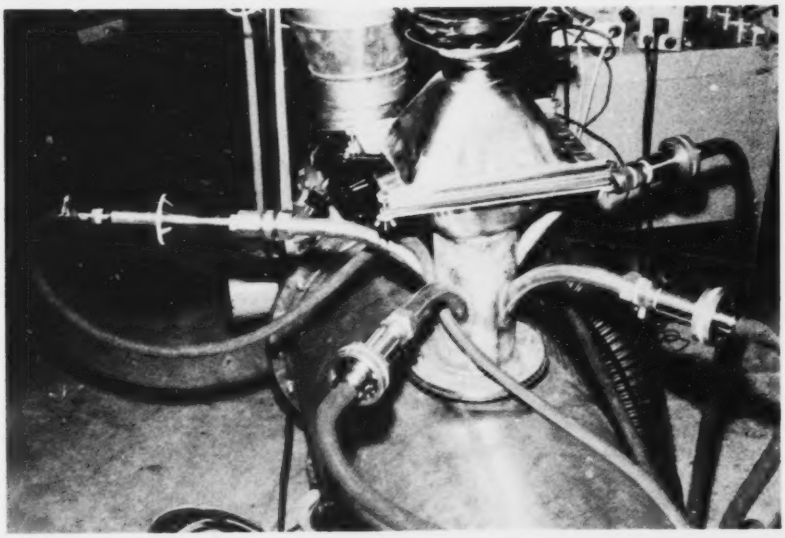

Figure 19. Particulate sampling probe external detail

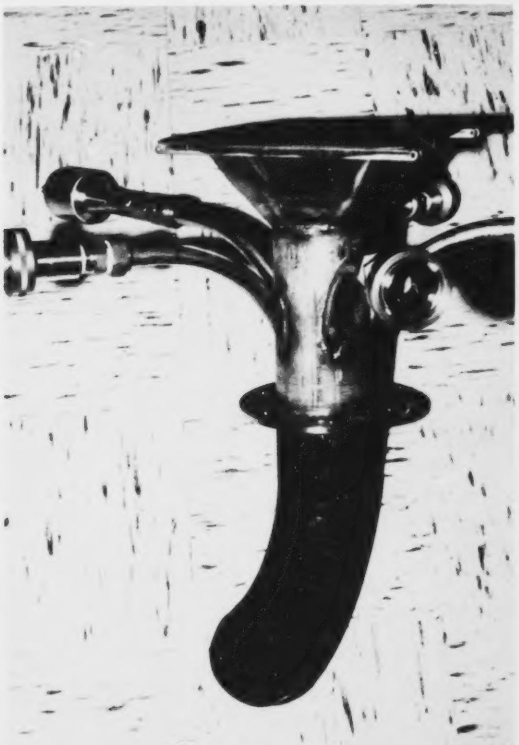

Figure 20. Particulate sampling probe internal detail

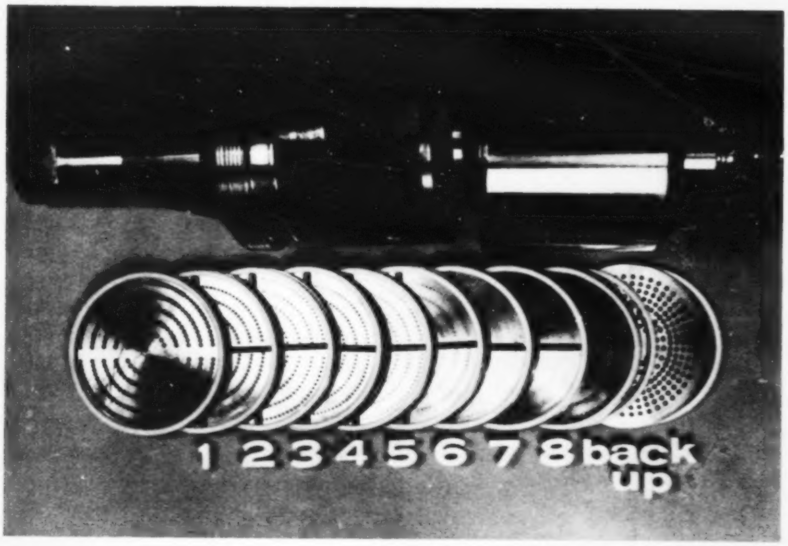
1
2
3
4
5
6
7
8
back up

Figure 21. Particle sizing impactor disassembled, without collection media

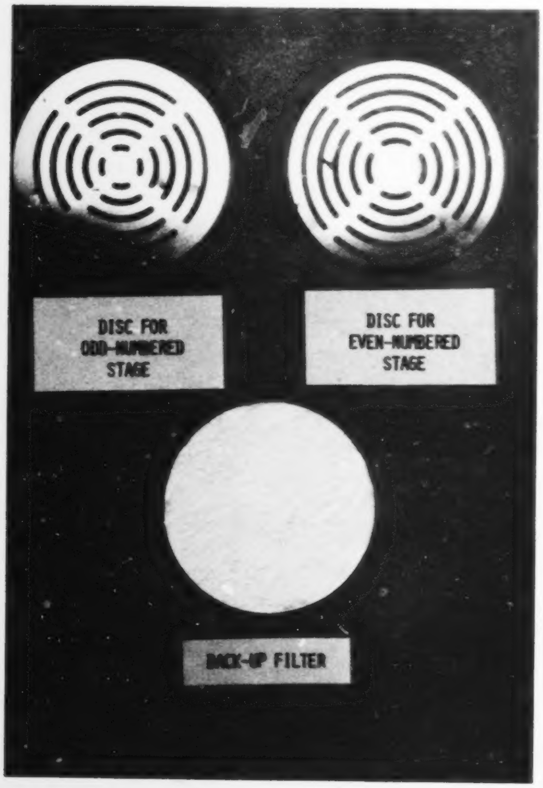
DISC FOR ODD-NUMBERED STAGE
DISC FOR EVEN-NUMBERED STAGE
BACK-UP FILTER

Figure 22. Unused discs and filter for impactor

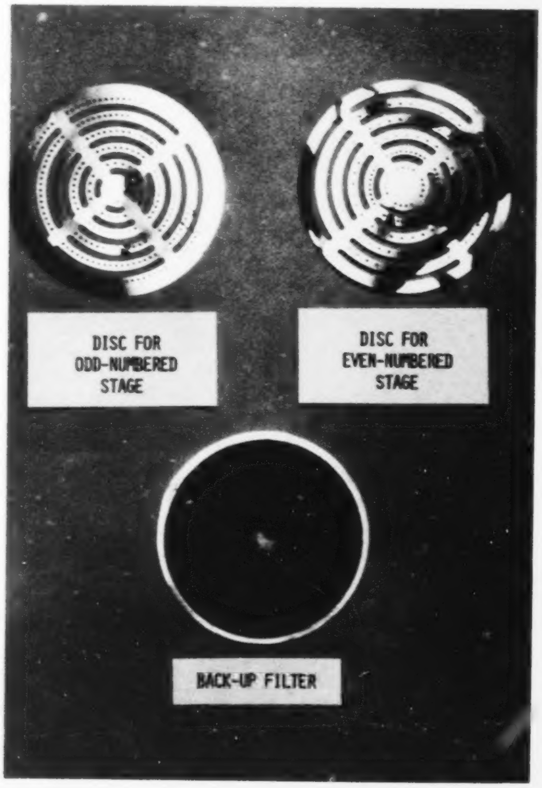
DISC FOR ODD-NUMBERED STAGE
DISC FOR EVEN-NUMBERED STAGE
BACK-UP FILTER

Figure 23. Discs and filter for impactor with collected sample

retention characteristics the same as the impactor plates. Glass fiber collection discs were tried early in the program, but proved to be unsatisfactory due to strong adsorbing properties and loss of fibers during sampling.

To determine the mass of particulate matter collected on sample filters and impactor discs, they were weighed before and after use on the microbalance shown in Figure 24. This balance is housed in a vibration-resistant, temperature- and humidity-controlled chamber to minimize variations in filter weights with time. Filters and discs were allowed to stabilize overnight, in most cases, before weights were measured. Air to the chamber flows at about 17 m^3/h on a one-pass basis, and keeps the chamber pressure at about 2.5 kPa above atmospheric. The control system keeps chamber conditions at 22.2 ± 0.6°C and 63 ± 2 percent relative humidity, and air entering the chamber is filtered through a 99.99+ percent DOP (dioctyl phthalate)-efficient filter. The microbalance itself can be read to mass increments of 1 μg.

G. Particle Sizing by Transmission Electron Microscope (TEM)

Two special tests were conducted to collect samples for particulate sizing by TEM. The purpose of this experiment, not initially included in the Test Plan (Section V), was to study the relationship between aerodynamic particle size distribution determined by inertial impactor and apparent size of collected particulate. Copper grids having a diameter of 3.0 mm and a thickness of 0.08 mm were attached to stainless impactor discs for these tests, one grid per disc. It was attempted to center each grid under one jet from the preceding stage, as shown in Figure 25. Figure 26 shows a grid much enlarged, having bars 26 μm across and holes 57 μm across. The grids were coated with a solution of 0.25 percent Formvar in ethylene dichloride prior to use, forming a thin layer to hold particles. This material was transparent to the TEM beam.

The TEM itself was a Hitachi HU-11C, operated with an accelerating potential of 75 kv. Photomicrographs were made at effective magnifications from about 7,000x to 111,000x, with statistical work done at 21,600x and 87,500x. Templates used to size particles and agglomerates are shown in Figure 27, calibrated in μm at 87,500x (27a. and 27b.) or 21,600x (27c. and 27d).

Earlier attempts were made to examine particles collected on stainless discs using a Scanning Electron Microscope (SEM). This instrument did not have adequate resolution to examine individual particles or agglomerates, so its use was discontinued. If this instrument were fitted with an improved emission source, it could do better than its present "smallest feature" resolution of about 0.015 μm. As currently equipped, however, its resolution is about the same as the smallest particles' diameter.

H. Analysis of Particulate Composition

Following acquisition and weighing of particulate samples, their composition was analyzed by a variety of techniques. Analyses included in this subsection are those for major elements, trace elements, sulfate, and phenols. Analysis of the soluble fraction of particulate matter is discussed in the next subsection (IV.I).

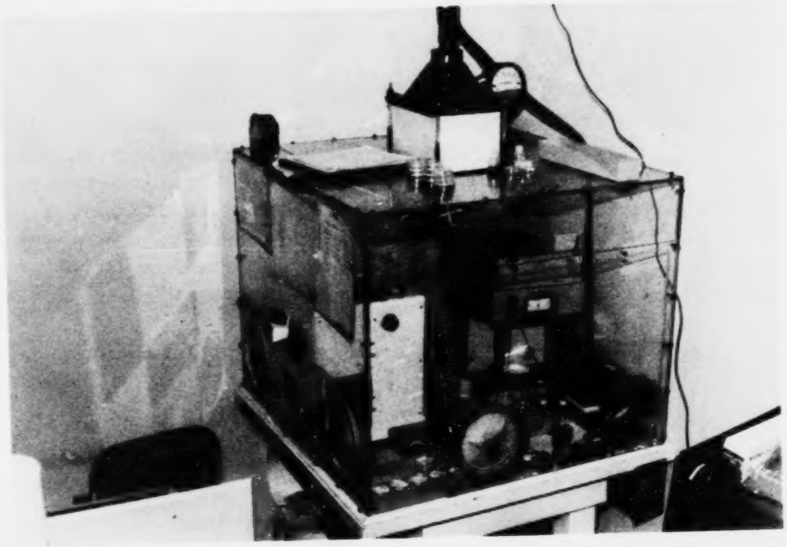

Figure 24. Microbalance used to weigh filters, with temperature-/humidity-controlled chamber

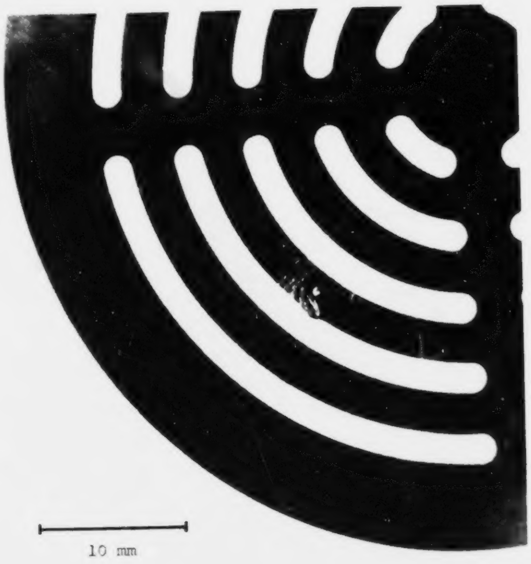

Figure 25. Collection grid for TEM study mounted on impactor disc

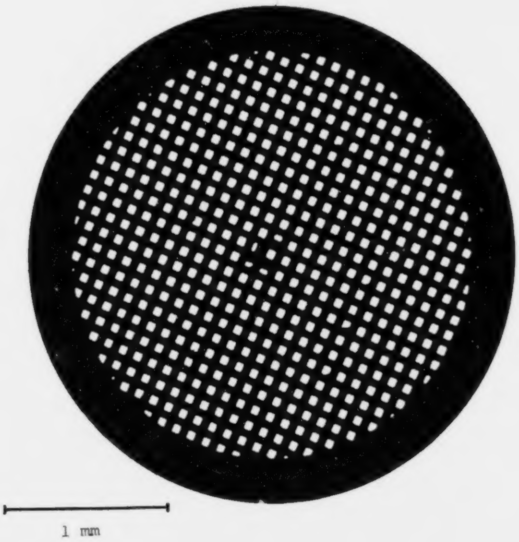

Figure 26. Collection grid for TEM study detail

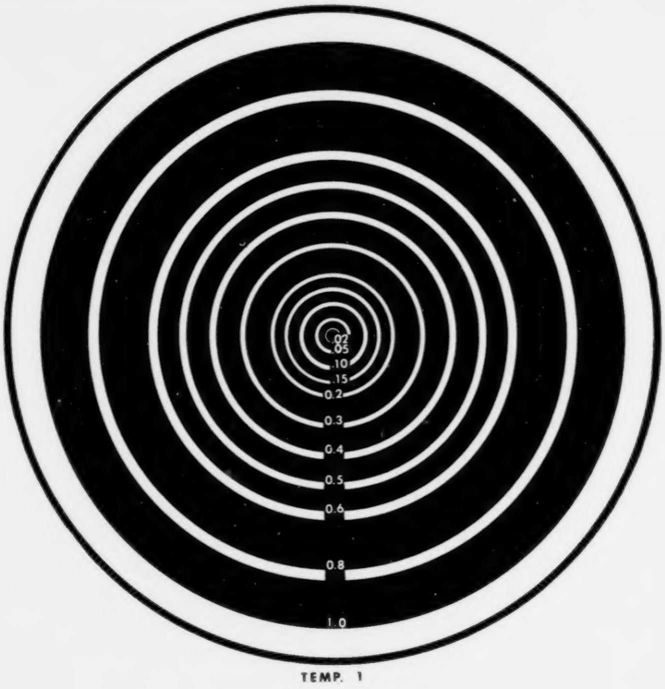
.02
.05
.10
.15
0.2
0.3
0.4
0.5
0.6
0.8
1.0
TEMP. 1

Fig. 27a

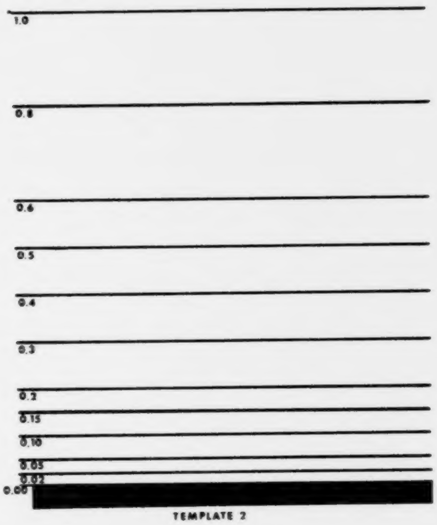
1.0
0.8
0.6
0.5
0.4
0.3
0.2
0.15
0.10
0.05
0.02
0.00
TEMPLATE 2

Fig. 27b

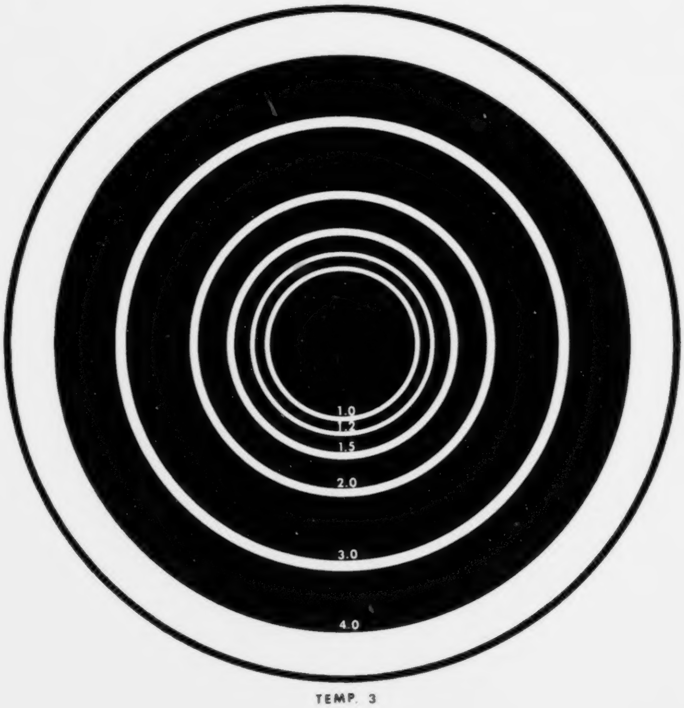
1.0
1.2
1.5
2.0
3.0
4.0
TEMP. 3

Fig. 27c

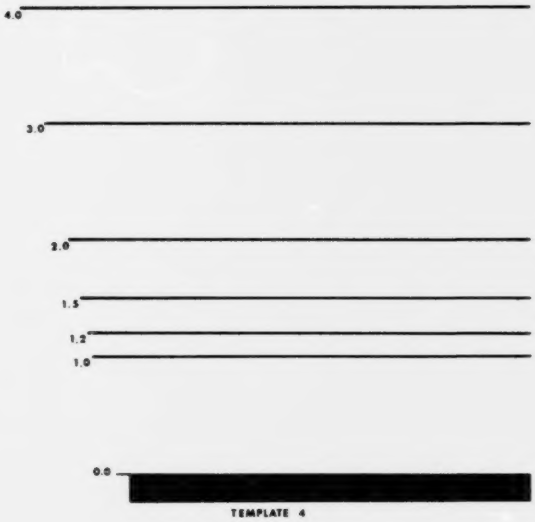
4.0
3.0
2.0
1.5
1.2
1.0
0.0
TEMPLATE 4

Fig. 27d

Figure 27. Templates for sizing agglomerates on TEM micrographs

1. Major Elements

Samples collected on 47 mm glass fiber filters were sent to Galbraith Laboratories and analyzed for carbon, hydrogen, and nitrogen content by combustion and subsequent gas analysis. The equipment used was a Perkin-Elmer Model 240 automated thermal conductivity CHN analyzer. Results of this analysis were reported in percent of submitted sample mass, making the accuracy of filter weighing very important. Blank filters were also submitted to permit blank corrections.

2. Trace Elements

Analysis for trace elements in particulate (sulfur and metals) was performed on 47 mm Fluoropore filter samples. As provided in the contract agreement, these determinations were made by EPA's Research Triangle Park laboratories as part of the EPA in-house measurement program. The instrumentation used for these analysis was a Siemens MRS-3 x-ray fluorescence spectrometer. It is automated and computer-controlled, with 16 fixed monochromators and one scanning monochromator. Counting intervals are normally 100 seconds for the fixed monochromators and 20 seconds for the scanning monochromator.

3. Sulfate

Sulfate ($SO_4^=$) analysis was performed on Fluoropore filter-collected samples using the barium chroranilate (BCA) technique(22). Samples were ammoniated in a closed container to convert sulfuric acid particulate to (stable) ammonium sulfate. After ammoniation, the soluble sulfates were extracted from the filters using a mixture of isopropyl alcohol and water. Part of the extract was passed through a strong cation exchange resin column, then through a BCA column to precipitate out barium sulfate. The colored chloranilate ions were measured colorimetrically with a Beckman Model 25 UV spectrophotometer at a wavelength of 310 nm. Data were processed using SwRI's Hewlett-Packard 3354 data system.

4. Phenols

The system used to collect samples for phenol analysis is shown schematically in Figure 28. It was originally intended that direct measurement of phenols in particulate be conducted, but problems with the analysis occurred repeatedly when the collection filter was involved in the extraction process. As indicated by the schematic, parallel impinger samples were taken (of undiluted exhaust) with and without filtration. It was intended that the system would provide phenol data on particulate, therefore, by the difference in filtered and unfiltered gas concentrations. Since phenol samples were taken isokinetically from undiluted exhaust, sampling was restricted to steady-state operating conditions (idle, 50 km/h, and 85 km/h).

After extraction from the collection reagent and several intermediate processing steps, diethyl ether extracts of the samples were injected into a GC with flame ionization detector (FID). This instrument was operated isothermally at 125°C, and was equipped with a 1.8 m (length) by 2.0 mm (diameter) glass column packed with 10 percent SP-2100 (a methyl silicone fluid) on 100/120 mesh Supelcoport. The analytical procedure is detailed in Appendix C, page C-3.

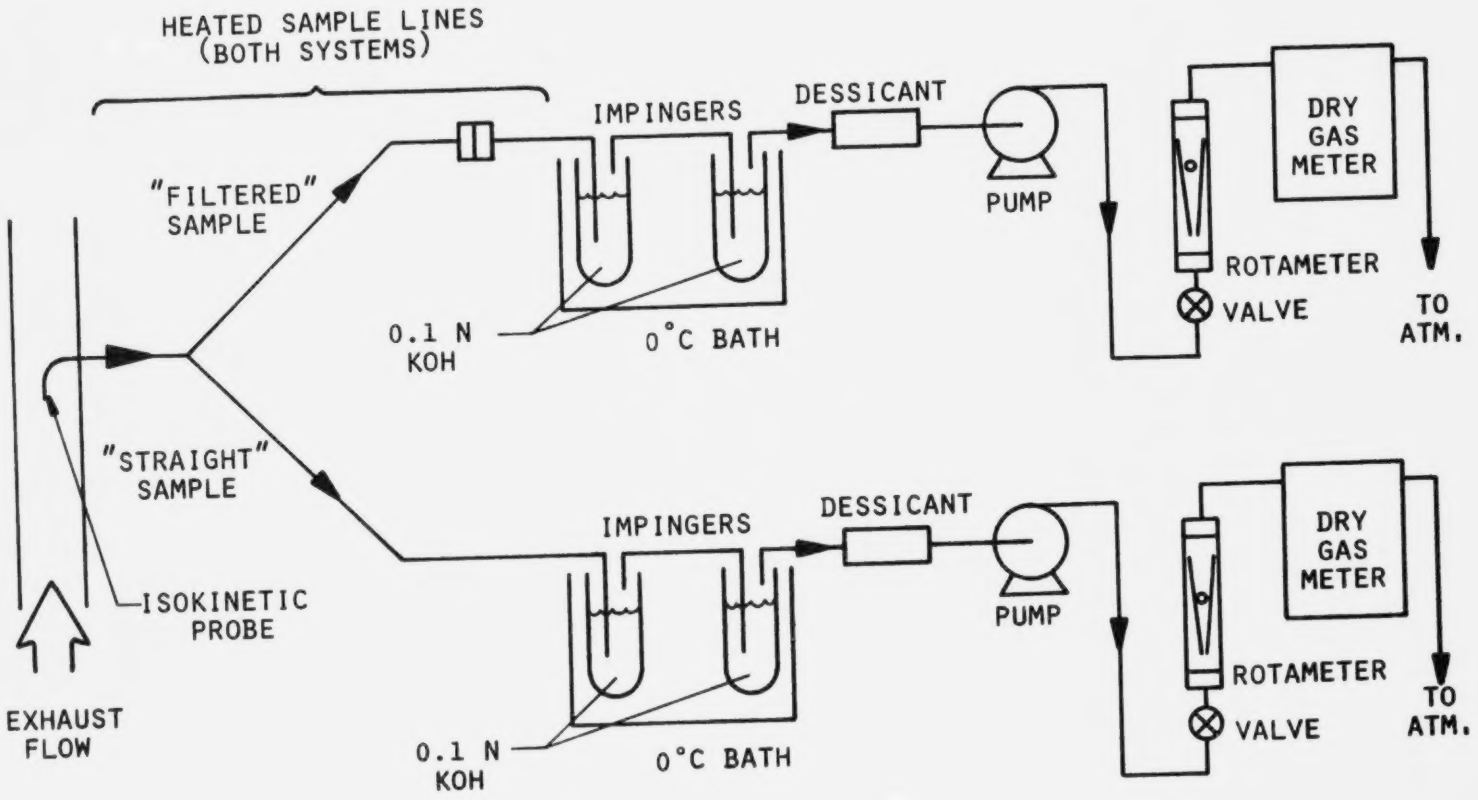
HEATED SAMPLE LINES
(BOTH SYSTEMS)
"FILTERED" SAMPLE
"STRAIGHT" SAMPLE
ISOKINETIC PROBE
EXHAUST FLOW
IMPINGERS
0.1 N KOH
0°C BATH
DESSICANT
PUMP
ROTAMETER
VALVE
DRY GAS METER
TO ATM.
IMPINGERS
0.1 N KOH
0°C BATH
DESSICANT
PUMP
ROTAMETER
VALVE
DRY GAS METER
TO ATM.

Figure 28. Schematic diagram of phenol sampling system

I. Analysis of the Soluble Fraction of Particulate Matter

The soluble fractions of particulate matter were obtained by extraction from a number of individual particulate samples. The individual solubles samples were subsequently combined into 10 composite samples (one representing each vehicle and fuel), and analyzed for a variety of constituents.

1. Total Soluble Organics

Samples collected on "8 x 10" (203 x 254 mm) glass fiber filters were extracted (one half each filter at a time) using cyclohexane in a Soxhlet apparatus. The solvent was driven off at low temperature in a preweighed container, and total mass of solubles was determined gravimetrically. Cyclohexane was chosen as the solvent not because it was considered superior for extraction purposes, but because it was the specified solvent to be used in the procedure for benzo-a-pyrene (BaP) analysis (discussed in Section 4.I.4.).

2. Major Elements

Approximately half of each composite solubles sample was dried at low temperature, then weighed in a preweighed container. The resulting samples were submitted to Galbraith Laboratories and analyzed for carbon, hydrogen, nitrogen, sulfur, and oxygen by the technique and instrumentation already described in Section 4.H.1.

3. Solubles Boiling Range and Individual n-Paraffin Analysis

Another portion of the solubles was used for boiling range and individual paraffin determinations by SwRI's Mobile Energy Division (formerly referred to as the U.S. Army Fuels and Lubricants Research Laboratory). The equipment used for this gas chromatograph analysis was a Hewlett-Packard 5700 Series unit, equipped with dual hydrogen flame ionization detectors. Its column was 1.8 m (length) by 3.2 mm (diameter) stainless steel, packed with 10 percent Dexsil 300 on 45/60 Chromosorb P, AW-DMCS. It was programmed from 0°C to 450°C at 15°C per minute after 2 minutes isothermal at 0°C. Data processing was performed on a Hewlett-Packard 3354 data system.

This gas chromatograph procedure is a high-temperature variation on ASTM D2887-73 which currently has no status as an ASTM procedure. It does provide a simulated distillation out to 600°C, and utilizes a C_9-C_{11} internal standard for determination of recovery and residue.

4. Benzo-a-pyrene (BaP)

Extractions of "8 x 10" filter halves produced samples for BaP (benzo-a-pyrene) analysis. Extracts were concentrated and spotted on TLC plates, and the plates were scanned by a Perkin-Elmer MPF-3 fluorescence spectrophotometer. Excitation was at a wavelength of 388 nm, and emission was read at 430 nm. The procedure and equipment were those of EPA's Research Triangle Park laboratories(23). A copy of this procedure is given for reference in Appendix C, pages C-4 through C-7.

V. TEST PLAN, OPERATING SCHEDULE, AND DATA REDUCTION

Each of the subjects dealt within this report section is essential to a complete description of the projects scope. To assure maximum clarity, these subjects will be discussed in separate subsections

A. Test Plan

The major problem overcome in structuring this project was the need for a very large number of individual test runs and emissions evaluations. Table 5 shows the scope of gaseous and particulate emissions to be evaluated, with collection and analysis techniques summarized as appropriate. Sizing of particles via electron microscopy was not included in the initial test plan, but was added later when it was decided that the resulting data might prove useful.

Combining as many sampling/collection procedures as possible, five types of analysis sequences were defined:

Sequence 1 - smoke

Sequence 2 - odor (DOAS and panel) + aldehydes, individual HC, total HC, CO, NO_x, CO_2

Sequence 3 - sulfate, sulfur, carbon, hydrogen, nitrogen, sizing and particulate mass emissions

Sequence 4 - phenols, organic extractables, BaP, molecular weight range of particulate hydrocarbons, and particulate mass emissions

Sequence 5 - total HC, CO, CO_2, and NO_x; wet collection for aldehydes; and column trapping for gaseous hydrocarbons

As it turned out, development of the 6-probe particulate sampler permitted combining of (original) Sequences 3 and 4 into (revised) Sequence 3, providing additional flexibility to conduct repeats of unsatisfactory runs, gaseous emissions with odor tests, and particulate sizing by electron microscopy.

The test plan utilizing these sequences is given in Table 6, yielding a total of 23 runs per vehicle-fuel combination (or 230 in all). Given the constraints of this program, the test plan as given was the most comprehensive which could be accomplished. We do not consider the single determinations which were made for some vehicle-fuel-test procedure combinations to be desirable, but they were necessary to meet the intent of the Scope of Work.

The test plan shown in Table 6 was conducted uniformly as a minimum, and a number of additional runs were made where necessary to replace erroneous data or supply missing information. These extra runs totalled 9 for the Mercedes 240D and 25 for the VW Rabbit Diesel, and they were all for particulate collection within (revised) Sequence 3.

TABLE 5. OUTLINE OF CHEMICAL AND PHYSICAL EXHAUST EVALUATIONS

Exhaust component under study	Constituent(s) analyzed for	Collection Method	Analysis technique(s)
smoke	smoke (visible)	----	EPA smokemeter (continuous)
gases	HC, CO, CO_2, NO_x	----	constant-volume sampler
	aldehydes	wet impinger	DNPH
	gaseous hydrocarbons	Chromosorb 102	extraction, GC
	odor	DOAS traps	human panel, DOAS analyzer
particulate	total mass	filters	gravimetric
	size distribution	impactor-filter	gravimetric
	sulfate	filter, 47 mm Fluoropore	BCA
	sulfur & trace elements	filter, 47 mm Fluoropore	X-ray fluorescence
	carbon, hydrogen, nitrogen	filter, 47 mm glass filter	combustion (commercial)
	phenols	wet impingers[a]	separation, GC
	organic extractable substances	hi-vol filter	soxhlet extraction
	BaP in organic solubles	----	TLC, fluorescence detection
	molecular weight range of organic solubles	----	GC

[a] parallel gas samples before and after filtration to determine phenols in particulate subtractively

TABLE 6. TEST PLAN FOR EACH VEHICLE-FUEL COMBINATION

(Revised) Sequence	Number of replicates by test procedure						Total Runs
	FTP	SET	FET	NYCC	Odor[a]	Steady-State[b]	
1 (smoke)	2	-	-	-	-	-	2
2 (odor)	-	-	-	-	2	-	2
3 (part.)	3[c]	2[c]	1[c]	1[c]	-	1	10
4 (gaseous)	3	1	1	1	-	1	9

[a] three runs inherent in procedure, aldehydes and individual HC run once only

[b] three conditions

[c] phenols not measured during transient runs

B. Vehicle Operating Schedules

As required by the contract, a number of different operating cycles and modes were used to determine emissions. For smoke measurements, the first 505 seconds of the FTP cycle (also referred to as the LA-4 or Urban Dynamometer Driving Schedule, UDDS) were used with both cold and hot starts. This schedule incorporates all the most interesting operational modes from a smoke standpoint, including engine start, first idle, first acceleration, second idle, and second acceleration. The remainder of each 505 second run generally produced more or less repetitive information. A graphical time-speed representation of the FTP cycle is given in Figure 29, along with graphs depicting the other cyclic procedures utilized for emission measurements during the project.

Basic statistics for all the cyclic and steady-state schedules used, except those solely for odor work, are summarized in Table 7. Computer printouts of the time-speed tabulations for the four cyclic schedules (FTP, CFDS or "sulfate-7", FET, and NYCC or "sulfate-8") are given as Appendix D. This inclusion is made due to the lack of ready availability of these tabulations in uniform format. Examining the statistics in Table 7, it is apparent that the desired wide range in average speed, speed variation, fraction of idle time, and cycle length were achieved with the selected tests. The effects of some of these cycle variables will be examined later in the report.

With the exceptions of phenols, elemental analysis of solubles from particulate, and GC-simulated boiling range of solubles from particulate, all the gaseous and particulate emissions data resulting from (revised) test Sequences 3 and 4 were determined for all the schedules listed in Table 7 (including both cold- and hot-start FTP's). Phenols were determined only for steady-state conditions because sampling for them was conducted isokinetically from raw exhaust. Elemental analysis and GC analysis of solubles from particulate matter were conducted only on "composite" samples of solubles, one sample representing each vehicle-fuel combination. These "composite" samples consisted of the combined cyclohexane extracts from two cold FTP half-filters (hi-vol filters), two hot FTP half-filters, two CFDS half-filters, and one half-filter from each of the remaining five schedules listed in Table 7.

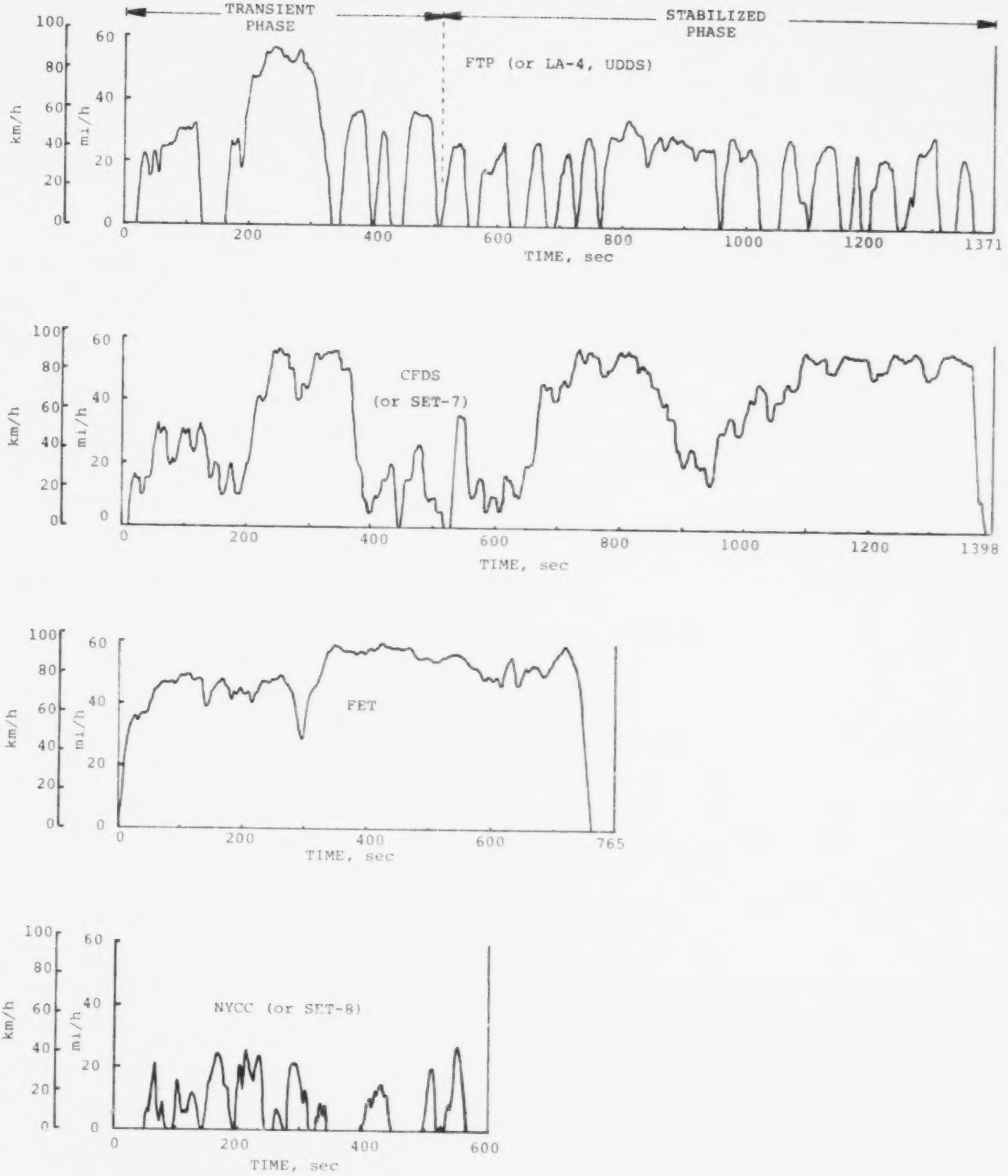

Figure 29. Speed-time traces of FTP, CFDS, FET, and NYCC operating conditions

TABLE 7. BASIC STATISTICS FOR VEHICLE OPERATING SCHEDULES[a]

Schedule	Value by statistic					
	Average speed, $\overline{V}$, km/h	Speed variability, $s_V/\overline{V}$	Stops/km	% Idle time	Length, km	Time, sec
FTP	31.46	0.752	1.42	19.0	11.98	1371
CFDS	55.94	0.516	0.14	2.6	21.74	1398
FET	77.52	0.213	0.06	0.8	16.47	765
NYCC	11.37	1.129	5.79	40.2	1.90	600
Idle	0	-	0	100	0	1200[b]
50 km/h	50.0	0	0	0	16.67[b]	1200[b]
85 km/h	85.0	0	0	0	28.33[b]	1200[b]

[a] not including odor schedules
[b] arbitrary

Operating schedules for odor measurement followed those developed for light-duty Diesels under a previous EPA Contract, No. 68-03-2116(9). In brief, they included seven steady-state conditions and four simple transients as described for the two test vehicles in Table 8. Steady-states were held long enough to obtain all the necessary concurrent emissions measurements, normally about five to seven minutes. Idle-accel transients required about four seconds, 48-80 km/h accelerations about 18 seconds, 80-48 km/h decelerations about 18 seconds, and cold starts about 30 seconds. Even for the short schedules, however, at least five minutes were allowed to elapse between (monentary) odor sampling periods. The two transient accelerations were conducted at full rack to maximize repeatability.

C. Data Reduction

This report subsection documents methods employed to reduce data for those measurements where such reduction was not trivial and not discussed elsewhere in the report. Each set of measurements requiring discussion is presented separately below.

1. Visible Smoke

As already described in section IV., primary smoke opacity measurement data were in the form of strip chart recordings covering cold-start and hot-start FTP transient phases (first 505 seconds). These charts were analyzed manually, resulting in peak and average estimates for several portions of the test schedule.

TABLE 8. DESCRIPTION OF ODOR MEASUREMENT SCHEDULES

Steady-state condition		Mercedes 240D			VW Rabbit diesel		
speed, km/h	load	engine rpm	observed dyno power,kW	gear	engine rpm	observed dyno power,kW	gear
0 (Idle)	----	710	----	N	900	-----	N
53	----	1800	0	N	2020	0	N
	mid	1800	9.3	4	2020	6.0	4
	high	1800	19.8	4	2020	13.4	4
90	----	3000	0	N	3360	0	N
	mid	3000	13.8	4	3360	12.3	4
	high	3000	29.1	4	3360	22.4	4

Transient condition		Mercedes 240D			VW Rabbit diesel		
type	speeds,km/h	inertia simul.,kg	load present @ 80 km/h, kW	gear	inertia simul.,kg	load present @ 80 km/h, kW	gear
cold start	-----	----	---	N	----	----	N
idle-accel.	0 - 32	1588	6.8	1	1270	5.4	1
accel.	48 - 80	1588	6.8	4	1270	5.4	4
decel.	80 - 48	1588	6.8	4	1270	5.4	4

2. Routine Gaseous Emissions (HC, CO, CO_2, NO_x)

Gaseous emissions required for certification tests were measured on bag samples of CVS-diluted exhaust during all the transient and steady-state operating schedules described (previously) in Table 7. Data for FTP runs were recorded on the form shown on page E-2 of Appendix E, while those for all the other schedules were recorded on the form given as page E-3.

In the case of FTP data, the "cold-FTP" results were computed using cold transient phase (bag 1) and stabilized phase (bag 2) data. "Hot FTP" data were computed using hot transient phase (bag 3) and stabilized phase (bag 2) data. Results for "3-bag" FTP tests were computed as conventional 1975 (and later) FTP runs.

The computer programs used to process the encoded data are given as pages E-4 through E-14 (FTP or "3-bag" program) and E-15 through E-27 (single-bag program) of Appendix E. These programs employ the complete computation methods given in Emissions Certification Regulations for light-duty Diesel vehicles (7). Typical output from the FTP program is shown on page E-28, and corresponding output from the single-bag program is given on page E-29.

3. Nonroutine Gaseous Emissions

Analysis of trap-collected samples for gaseous hydrocarbons was not quantitative, but rather only descriptive. After carbon disulfide (CS_2) elution from the traps, the samples were run on a gas chromatograph-simulated distillation procedure (ASTM D2887-73)(24) without internal standard. The GC output was computer-processed to yield boiling range and peak data. After solvent correction, boiling range was transcribed to report form. Qualitative peak data were examined for n-paraffins, and the relative abundances of these paraffins were computed for reporting.

Aldehyde analysis by the DNPH method(15) was quantitative and the gas chromatograph output was in the form of individual aldehyde dinitrophenylhydrazone derivative mass concentrations in the solution analyzed. These data were multiplied by factors to remove the influence of substituted hydrazone groups on molecular weight. The resulting values were multiplied by the ratio of total CVS flow during the test to total sample flow, yielding aldehyde emissions in mass per test.

4. Particulate Mass Rate and Concentration

Since each vehicle's entire exhaust flow was diluted in the tunnel during the subject tests, computation of particulate mass rate was much simpler than for the case in which a portion of the engine's exhaust is diluted (e.g. heavy-duty engines tested under other EPA Contracts)(3,6,9,10). The basic relationship used for mass emission calculations was:

$$\left(\frac{\text{mass particulate emitted}}{\text{test}}\right) = \left(\frac{\text{mass particulate on filter}}{\text{dilute sample mass through filter}}\right)_i \quad x$$

$$\left[\text{dilute mass through tunnel blower} + \sum_{i=1}^{6} (\text{dilute sample mass through filter})_i\right],$$

where "i" is the sampler number. For these tests, samplers 1 and 2 used 47 mm Fluoropore filters, samplers 3 and 4 used 47 mm glass fiber filters, sampler 5 was the impactor, and sampler 6 was the hi-vol. The value of (particulate mass emitted/test) resulting from the above expression was divided by test distance to yield g/km and by test time to yield g/h. The hand calculator program used to process test data is given as Appendix E pages E-30 through E-33, and a typical (filled-in) data sheet is given as page E-34.

Tests using a CVS or a dilution tunnel for exhaust collection did not inherently produce data on vehicle exhaust mass or volume flows. In order to calculate concentrations of particulate emitted, therefore, it was necessary to conduct a series of tests to measure engine air flows over the various operating schedules used. Data were acquired by continuous laminar flow element measurement, with both chart readout and integrated air flow via a pressure transducer/integrator/counter assembly. Corrections were made for differences in engine inlet air temperature and pressure caused by substitution of the air flow measurement system for each vehicle's normal air inlet system. Data resulting from these tests are given in Table 9, assuming exhaust density and air density to be equal at

TABLE 9. AIR AND EXHAUST FLOW DATA USED TO COMPUTE EMITTED PARTICULATE CONCENTRATIONS

Operating	Air, kg/test		Fuel, kg/test[a]		Exhaust, m^3/test[b]		Multiplier[c]	
Procedure	Mercedes	VW	Mercedes	VW	Mercedes	VW	Mercedes	VW
FTPC	45.4	41.4	0.948	0.622	38.7	35.0	311.89	344.86
FTPH	44.8	38.7	0.852	0.566	38.1	32.8	316.80	367.99
CFDS	57.8	50.2	1.345	0.908	49.3	42.7	440.97	509.13
FET	36.2	32.0	0.936	0.635	31.0	27.2	531.61	605.88
NYCC	13.8	12.0	0.229	0.139	11.7	10.1	205.98	238.61
Idle	13.0	15.5	0.175	0.128	11.0	13.0	30.30	25.64
50 km/h	36.0	31.2	0.666	0.498	30.6	26.4	545.75	632.58
85 km/h	63.1	54.9	1.571	1.077	53.9	46.7	527.46	608.78

[a] mean value over all fuels

[b] at 101.3 kPa and 21°C

[c] unrounded; based on $\mathrm{mg/m^3} = \mathrm{g/km} \times \left[\frac{1}{\mathrm{m^3/test}} \times \frac{1000\ \mathrm{mg}}{\mathrm{g}} \times \frac{\mathrm{km}}{\mathrm{test}}\right] = \mathrm{g/km} \times \mathrm{Multiplier}$

or $\mathrm{mg/m^3} = \mathrm{g/h} \times \left[\frac{1}{\mathrm{m^3/test}} \times \frac{1000\ \mathrm{mg}}{\mathrm{g}} \times \frac{1\ \mathrm{h}}{3\ \mathrm{tests}}\right] = \mathrm{g/h} \times \mathrm{Multiplier}$

1.99 kg/m^3 (101.3 kPa and 21°C), which introduces negligible error for combustion effluents from Diesels (0.05%)$^{(25)}$. In addition to using the multipliers to compute particulate emissions in mg/m^3 (from g/km or g/h), data in Table 9 could be used to calculate average F/A (fuel:air ratio) for all the procedures.

5. Particle Sizing by Inertial Impactor and Electron Microscopy

Aerodynamic particulate sizing using the inertial impactor was carried out using particulate weights on the nine individual collection stages (eight discs plus the backup filter). These data were not reduced to units of mass/test or mass/km, but were rather computed in terms of stage percent of total sample mass and cumulative stage percent of total sample mass. The resulting information was placed in computer storage so that it could be analyzed in groups of tests, e.g., all Mercedes tests or all VW tests, all tests of a given type for each vehicle, all tests on a given fuel for each vehicle, and so on. Groups of data were graphed on log-probability plots (cumulative data) and rectangular plots (individual stage percentages, excluding filter stage).

Using the templates already shown in Figure 27, particles and agglomerates appearing in TEM micrographs were sized and tabulated. The smallest (individual) particles fell below the smallest template calibration (0.02 μm), so they were counted prior to sizing the other agglomerates. The data form used to record the raw data is given as page E-35 of Appendix E. Sizes recorded in the "circle" columns were those measured by the circular templates (largest diameter), and those recorded in the "line" columns were those measured by the "line" template (minimum chord).

Raw data were grouped and summarized on the form given as page E-36 of Appendix E, with numbers of particles transcribed into the top section and percentages of particles computed for the bottom section. Data from four separate micrographs at 87,500x effective magnification were tabulated on each summary form, and data from the four micrographs were combined in one of the remaining columns to represent results from one collection stage. Most of these steps were not necessary for the larger agglomerates sized at 21,600x, since very few of them exceeded 1.0 μm apparent diameter.

6. Particulate Composition

Data on major elements in particulate matter (carbon, hydrogen, and nitrogen) were reported in percent of particulate mass, so no data reduction was required. Total solubles were reported in mass per half-filter extracted, so the only reduction necessary was to recompute the values in percent of particulate mass. Sulfur and trace elements were reported in $\mu g/cm^2$ on the filter analyzed, and these values were multiplied by the effective filtration area (14.64 cm^2) to yield μg/filter. For most of the trace elements analyzed, the mass per filter was simply recomputed in percent of collected particulate mass. For sulfur, this percentage was used with previously-computed total particulate emissions in grams/km to calculate sulfur in mg/km.

Sulfate raw data were in the form of peak areas corresponding to $SO_4^=$ concentrations in solutions used to extract sulfate from filters. These areas, determined by computer, were compared against areas for standard solutions to yield $SO_4^=$ in μg/filter. Sulfate was calculated in mg/km using these data as fractions of previously computed total particulate mass emissions.

Phenol raw data were in the form of μg of individual phenol compounds in total unfiltered and filtered exhaust samples taken from raw exhaust under steady-state conditions. Having measured the amount of exhaust constituting each sample, phenols in μg/test were calculated by multiplying phenols in the sample by the ratio of total exhaust to exhaust sampled. Division of these values by test distance (or test time, in the case of idles) yielded phenol emissions in mg/km (or mg/hr for idles). For the cases in which phenols from unfiltered exhaust exceeded those from filtered exhaust (the expected result), the "filtered" values were subtracted from the "unfiltered" values to yield phenols in particulate. The "filtered" values were used to represent phenols in exhaust gases.

Data on major elements in solubles (carbon, hydrogen, nitrogen, sulfur, and oxygen) were reported as received, in weight percent of solubles. Data on BaP in solubles were reported in ng/half-filter, and were subsequently calculated in μg/km using the reported BaP values as fractions of previously-computed total particulate emissions.

Gas chromatograph-simulated distillation of solubles from particulate matter were reported as chart output, peaks (individual compounds) as percentages of total sample mass, and a numerical boiling point distribution (percent distilled off as a function of temperature). The only reduction necessary for these data was to compute relative abundances of peaks identified as n-paraffins, and to compute the total percentage of peak areas identified as n-paraffins.

VI. GASEOUS EMISSION AND ODOR RESULTS

This report section includes presentation and discussion of results on regulated gaseous emissions, aldehydes, gaseous phenols, hydrocarbons collected by activated traps, and exhaust odor by panel and DOAS analyzer. Additional aldehyde, regulated emissions, and individual hydrocarbon data are given with odor results

A. Regulated Gaseous Emissions Results

Data on regulated gaseous emissions, including CO_2 and fuel consumption, were obtained by analysis of bag samples from CVS-diluted exhaust. These results are presented in Table 10 for the Mercedes 240D, and in Table 11 for the VW Rabbit Diesel. Most of the trends in these data are rather weak, the major exception being comparatively high hydrocarbon values for the VW Rabbit when operated on EM-241-F "minimum quality" No. 2 fuel. This trend is most apparent for test procedures containing substantial idle time, such as the FTP, the NYCC, and (of course) the steady-state idle.

These regulated emissions data are also found tabulated on pages F-2 and F-4 of Appendix 4, with average data used for FTP tests. All these data (except idle, already in g/h and ℓ/h) have also been recomputed on a time-rate basis to fulfill Contract requirements and provide input for certain statistical analysis purposes. The time-rate data are given on pages F-6 and F-8 of Appendix F.

B. Aldehyde Results

Concentrations of a number of individual low-molecular weight aldehydes (formaldehyde through benzaldehyde) were determined in CVS-diluted exhaust for both vehicles and all five fuels. These data are too voluminous to include in the text, but they are given in complete form in Appendix F, pages F-2 and F-4 (mg/km) and F-6 and F-8 (mg/h). Note that the "acetone" values also include acrolein and propanal, since these three compounds could not be resolved by the GC. A summary of the data is given in Table 12, including only "total aldehyde" values (the sum of the 7 individual aldehyde classifications).

Referring to Table 12, few clear trends are evident regarding fuel effects. It is obvious, however, that the test procedures influenced aldehyde emissions quite strongly, with steady-states generally producing the lowest values per unit distance traveled. It also appears that overall, the VW Rabbit Diesel produced somewhat higher "total" aldehydes than the Mercedes 240D.

C. Gaseous Phenol Results

Phenols as measured in filtered, undiluted exhaust were taken to represent gaseous phenols, and these results are given in Table 13. Of

TABLE 10. REGULATED GASEOUS EMISSIONS DATA FOR A MERCEDES 240D OPERATED ON FIVE DIESEL FUELS

Fuel	Item	Emissions (g/km) and fuel usage (ℓ/100 km) by driving schedule								
		3-bag FTP test number[a]						Steady-States		
		1	2	3	CFDS	FET	NYCC	Idle[b]	50 kph	85 kph
EM-238-F	HC	0.13	No	0.11	0.09	0.06	0.27	2.22	0.08	0.08
2D Emissions	CO	0.57	Data	0.57	0.39	0.35	1.11	6.63	0.27	0.36
	CO_2	225.		228.	188.	172.	354.	1630.	124.	172.
	NO_x	0.79		0.77	0.84	0.68	1.17	5.88	0.47	0.84
	fuel	8.42		8.54	7.03	6.43	13.2	0.616	4.64	6.44
EM-239-F	HC	0.14	0.26	0.16	0.08	0.06	0.27	2.10	0.06	0.06
"Nat'l Avg."	CO	0.65	0.64	0.63	0.45	0.40	1.31	6.18	0.27	0.41
	CO_2	239.	232.	220.	194.	175.	382.	1530.	132.	175.
	NO_x	0.79	0.82	0.75	0.72	0.73	1.27	5.70	0.50	0.77
	fuel	8.91	8.68	8.22	7.24	6.53	14.3	0.578	4.95	6.56
EM-240-F	HC	0.04	0.12	0.10	0.06	0.04	0.15	1.38	0.04	0.05
"Jet A"	CO	0.58	0.56	0.56	0.45	0.41	1.32	6.12	0.25	0.40
No. 1	CO_2	230.	223.	230.	201.	188.	401.	1820.	119.	181.
	NO_x	0.73	0.74	0.73	0.69	0.69	1.34	6.48	0.41	0.70
	fuel	8.59	8.33	8.60	7.52	7.01	15.0	0.685	4.43	6.76
EM-241-F	HC	0.19	0.22	0.20	0.08	0.05	0.33	2.97	0.06	0.06
"Minimum	CO	0.71	0.72	0.71	0.48	0.40	1.55	7.59	0.30	0.40
Quality"	CO_2	257.	253.	241.	210.	188.	410.	1740.	131.	184.
No. 2	NO_x	0.88	0.88	0.87	0.83	0.80	1.40	7.47	0.49	0.70
	fuel	9.63	9.49	9.03	7.86	7.03	15.4	0.655	4.91	6.86
EM-242-F	HC	0.11	0.13	0.12	0.07	0.05	0.20	1.38	0.06	0.05
"Premium"	CO	0.60	0.72	0.71	0.45	0.41	1.25	5.94	0.25	0.40
No. 2	CO_2	230.	271.	253.	183.	173.	349.	1510.	124.	159.
	NO_x	0.77	0.93	0.86	0.71	0.69	1.24	5.61	0.45	0.68
	fuel	8.60	10.1	9.45	6.85	6.48	13.1	0.567	4.64	5.96

[a] averages of FTP data given in Appendix F

[b] emissions in grams per hour instead of g/km, fuel in ℓ/h instead of ℓ/100 km

TABLE 11. REGULATED GASEOUS EMISSIONS DATA FOR A
VW RABBIT DIESEL OPERATED ON FIVE DIESEL FUELS

Fuel	Item	Emissions (g/km) and fuel usage (ℓ/100 km) by driving schedule								
		3-bag FTP test number[a]			CFDS	FET	NYCC	Steady-States		
		1	2	3				Idle[b]	50 kph	85 kph
EM-238-F 2D Emissions	HC	0.15	0.15	0.18	0.08	0.11	0.55	7.38	0.10	0.08
	CO	0.48	0.50	0.48	0.36	0.32	1.08	14.4	0.27	0.33
	CO_2	151.	149.	158.	127.	116.	227.	1110.	92.	119.
	NO_x	0.61	0.59	0.56	0.53	0.53	0.81	4.65	0.31	0.55
	fuel	5.66	5.57	5.91	4.74	4.35	8.54	0.432	3.44	4.45
EM-239-F "Nat'l Avg." No. 2	HC	0.19	0.24	0.19	0.12	0.10	0.39	6.48	0.07	0.10
	CO	0.54	0.50	0.49	0.42	0.38	1.16	12.5	0.23	0.36
	CO_2	151.	147.	151.	131.	121.	228.	1090.	95.	117.
	NO_x	0.62	0.67	0.65	0.50	0.57	0.98	4.89	0.34	0.57
	fuel	5.66	5.51	5.63	4.92	4.52	8.58	0.421	3.55	4.38
EM-240-F "Jet A" No. 1	HC	0.14	0.18	0.20	0.12	0.15	0.33	3.60	0.05	0.13
	CO	0.55	0.55	0.56	0.42	0.46	1.18	10.6	0.29	0.46
	CO_2	150.	151.	156.	130.	121.	224.	1190.	91.	119.
	NO_x	0.57	0.58	0.57	0.51	0.48	0.79	5.73	0.31	0.84
	fuel	5.63	5.65	5.85	4.87	4.55	8.44	0.456	3.40	4.47
EM-241-F "Minimum Quality" No. 2	HC	0.67	0.67	0.79	0.20	0.15	1.35	17.5	1.06	0.20
	CO	0.76	0.80	0.87	0.43	0.34	1.90	28.0	0.92	0.33
	CO_2	157.	167.	163.	134.	123.	241.	1310.	94.	120.
	NO_x	0.59	0.58	0.57	0.57	0.52	0.89	5.52	0.30	0.53
	fuel	5.97	6.33	6.22	5.02	4.61	9.23	0.527	3.68	4.51
EM-242-F "Premium" No. 2	HC	0.19	0.25	0.18	0.10	0.11	0.37	6.39	0.07	0.08
	CO	0.47	0.59	0.49	0.38	0.39	0.96	11.9	0.19	0.35
	CO_2	157.	166.	147.	136.	126.	232.	1120.	95.	121.
	NO_x	0.60	0.68	0.60	0.57	0.58	0.89	4.77	0.38	0.60
	fuel	5.90	6.20	5.58	5.09	4.71	8.70	0.432	3.54	4.54

[a] averages of FTP data given in Appendix F

[b] emissions in grams per hour instead of g/km, fuel in ℓ/h instead of ℓ/100 km

TABLE 12. SUMMARY OF "TOTAL" ALDEHYDE MASS EMISSIONS

Vehicle	Operating Schedule	"Total" aldehyde mass emissions by test fuel, mg/km[a]				
		EM-238-F	EM-239-F	EM-240-F	EM-241-F	EM-242-F
Mercedes 240D	FTPC[b]	18.	13.	16.	21.	14.
	FTPH[b]	16.	18.	16.	26.	19.
	CFDS	8.3	14.	11.	18.	7.4
	FET	8.4	17.	24.	8.1	8.7
	NYCC	81.	53.	31.	39.	52.
	Idle[a]	330.	160.	170.	250.	430.
	50 km/h	7.2	2.0	5.2	4.7	6.9
	85 km/h	4.9	1.6	3.2	3.5	3.4
VW Rabbit	FTPC[b]	35.	16.	18.	65.	18.
	FTPH[b]	24.	10.	18.	43.	10.
	CFDS	83.	32.	15.	10.	1.8
	FET	13.	11.	9.1	9.8	8.1
	NYCC	94.	76.	36.	53.	75.
	Idle[a]	860.	1200.	410.	940.	970.
	50 km/h	20.	7.7	9.5	38.	8.7
	85 km/h	8.4	4.8	6.3	8.8	5.4

[a] idle emissions in mg/h instead of mg/km
[b] average of three runs

the compounds analyzed, p-cresol was found in more samples than any of the others (24), followed by o-cresol (10), 2,3- & 3,5-xylenol (5), and 2,4- & 2,5-xylenol (2). As noted at the bottom of Table 13, several other compounds analyzed for were not detected in any of the samples.

Phenols were found in more gas samples from the Volkswagen than from the Mercedes, and a greater range in amounts of phenols in the gases as a function of fuel was also noted for the VW. In particular, the VW produced higher phenol concentrations when operated on fuel EM-241-F ("minimum quality" No. 2) than it did when operated on the other fuels. In all cases, gaseous phenol levels were numerically quite low (maximum time rate under 32 mg/h). The phenol data are given as computer output on pages F-2 through F-5 of Appenidx F in mass per unit distance, and again on pages F-6 through F-9 in mass per unit time.

D. Analysis of Trap-Collected Gaseous Hydrocarbons

Hydrocarbons were collected from filtered, dilute exhaust on traps, and the CS_2 elutions from these traps were analyzed qualitatively by gas chromatograph for boiling range and for paraffin peaks. Some of these

TABLE 13. GASEOUS PHENOL RESULTS

Vehicle	Operating Schedule	Compounds(s)	Gaseous phenols in mg/km[a]				
			EM-238-F	EM-239-F	EM-240-F	EM-241-F	EM-242-F
Mercedes 240D	Idle[a]	o-cresol +[c]	0[d]	0	0	0	0
		p-cresol	0	0	0.38	0.52	0
		2,4- & 2,5-xylenol	0	0	0	0	0
		2,3- & 3,5-xylenol	0	0	0	0	0
	50 km/h	o-cresol +[c]	0	0	0	0	0
		p-cresol	0	0.010	0.0096	0.021	0
		2,4- & 2,5-xylenol	0	0	0	0	0
		2,3- & 3,5-xylenol	0	0	0	0	0
	85 km/h	o-cresol +[c]	0.032	0.026	0	0	0.017
		p-cresol	0.030	0.024	0.021	0.026	0.028
		2,4- & 2,5-xylenol	0	0	0	0	0
		2,3- & 3,5-xylenol	0	0	0	0	0
VW Rabbit diesel	Idle[a]	o-cresol +[c]	0	0	0	0	0
		p-cresol	0.35	0.22	0.67	6.7	0.54
		2,4- & 2,5-xylenol	0	0	0	0.16	0
		2,3- & 3,5-xylenol	0	0	0	6.7	0
	50 km/h	o-cresol +[c]	0.026	0	0.0074	0.10	0
		p-cresol	0.053	0.023	0.023	0.27	0.011
		2,4- & 2,5-xylenol	0	0	0	0.0037	0
		2,3- & 3,5-xylenol	0.014	0	0.0074	0.16	0
	85 km/h	o-cresol +[c]	0.035	0.027	0.063	0.087	0.038
		p-cresol	0.036	0	0.071	0.21	0.048
		2,4- & 2,5-xylenol	0	0	0	0	0
		2,3- & 3,5-xylenol	0	0	0	0.078	0

[a] mg/h instead of mg/km

[b] analysis also conducted for: phenol; 2,3,5-trimethylphenol; 2,6-xylenol; and 3,4-xylenol; but these four compounds were not detected

[c] o-cresol + salicyaldehyde

samples remained at a low concentration even after evaporation due to low HC levels in the exhaust, resulting in a substantial number of samples for which analysis was either partially successful or totally unsuccessful. These data gaps show up in the complete tabular data, given as pages F-10 through F-19 of Appendix F.

Summaries of the trap-collected gaseous HC data are given in Tables 14 and 15 for the Mercedes and the VW, respectively. For comparison, gas chromatograph analysis of the test fuels themselves is presented in a similar format in Table 16. The "Average No. 2" column at the right in each table lists mean values for all the fuels except EM-240-F, the No. 1 fuel.

Boiling range temperatures (simulated distillation data) for the gaseous HC samples were generally higher than for corresponding fuels, with greater differences between gaseous HC and fuel occurring for EM-240-F (+113 to +216°C) than for the average of the No. 2 fuels (+1 to +65°C). In fact, gaseous HC from tests on EM-240-F (No. 1 fuel) had a substantially higher boiling temperature range than the average gaseous HC boiling range from tests on No. 2 fuel. This fact runs counter to expectations based on the assumption that gaseous HC is closely related to "unburned" fuel in composition, and it supports the idea that the hydrocarbons are either combustion products or combustion-modified fuel constituents. The data on which these observations are based can hardly be considered conclusive, however, due to the relatively small number of samples analyzed. Figures 30 (Mercedes) and 31 (VW) show boiling ranges of EM-240-F (fuel and HC emissions) as representative of No. 1 fuel and for the average of data for No. 2 fuels and corresponding HC emissions.

E. Results of Odor Evaluations and Corresponding Emissions Tests

This subsection contains results from both odor panel and instrumental odor evaluations, as well as corresponding emissions results. Detailed data on the odor panel evaluations are given in Appendix F, pages F-20 through F-29. Detailed data on gaseous emissions and DOAS results are given on pages F-30 through F-39, and data on aldehyde and low molecular weight "individual HC" concentrations are presented as pages F-40 through F-45. For those evaluations conducted twice per vehicle-fuel combination (odor, regulated gaseous emissions), the day-to-day repeatability was generally very good.

Data on the Mercedes 240D, Table 17, exhibit little variation as an apparent function of fuel, and only moderate variation as an apparent function of vehicle operating conditions. Both panel and DOAS odor intensity ratings are slightly greater overall at high loads than at low loads, but this trend appears to correlate negatively (and weakly) with most of the hydrocarbons and aldehydes measured. Of the odor ratings on transients, those for decelerations are highest overall.

TABLE 14. SUMMARY OF GAS CHROMATOGRAPH ANALYSIS[a] OF TRAP-COLLECTED GASEOUS HYDROCARBONS, MERCEDES 240D

Weight % Off	Average Temperature in °C by fuel					
	EM-238-F	EM-239-F	EM-240-F	EM-241-F	EM-242-F	Avg. No. 2
0 (IBP)	181	219	248	152	134	172
5	216	241	260	199	197	213
10	239	252	271	226	220	234
20	268	268	291	259	248	261
40	301	294	338	295	286	294
60	330	322	369	332	321	326
80	370	355	408	377	374	369
90	394	376	423	407	409	396
95	408	387	433	428	427	412
100 (EP)	426	399	447	453	450	432

Carbon Number	Average normalized abundance of (fraction of total) n-paraffins by fuel					
	EM-238-F	EM-239-F	EM-240-F	EM-241-F	EM-242-F	Avg. No. 2
9	0.004			0.003		0.002
10	0.009	0.002	0.004	0.007		0.004
11	0.003	0.002	0.006	0.001		0.002
12	0.009	0.019	0.069	0.002	0.080	0.028
13	0.050	0.038	0.074	0.010	0.093	0.048
14	0.094	0.174	0.140	0.096	0.078	0.110
15	0.138	0.153	0.064	0.119	0.133	0.136
16	0.110	0.126	0.074	0.126	0.142	0.126
17	0.181	0.168	0.103	0.149	0.204	0.176
18	0.167	0.099	0.036	0.100	0.138	0.126
19	0.130	0.100	0.087	0.166	0.082	0.120
20	0.068	0.058	0.036	0.024	0.042	0.048
	0.004					0.001
	0.002					0.000
	0.001					0.000
24	0.004	0.009	0.149	0.164	0.010	0.047
25 or 26	0.006		0.029			0.002
28	0.020	0.030	0.125	0.028		0.020
32		0.013	0.002	0.006		0.005
36		0.005	0.002	0.001		0.002
40		0.004				0.001
% peak data[b]	68.8	55.9	52.4	46.7	77.8	62.3

[a] by ASTM D2887-73 simulated distillation

[b] sum of paraffins as % of peak area by G.C.; peak area less than total sample area

TABLE 15. SUMMARY OF GAS CHROMATOGRAPH ANALYSIS[a] OF TRAP-COLLECTED GASEOUS HYDROCARBONS, VW RABBIT DIESEL

Weight % Off	Average Temperature in °C by fuel					
	EM-238-F	EM-239-F	EM-240-F	EM-241-F	EM-242-F	Avg. No. 2
0 (IBP)	187	222	249	169	213	198
5	226	239	265	208	233	226
10	243	250	278	235	245	243
20	265	264	299	250	263	260
40	295	287	352	268	293	286
60	320	306	398	284	318	307
80	356	327	442	304	342	332
90	382	340	469	316	360	350
95	404	347	488	328	372	363
100 (EP)	449	355	516	342	389	384

Carbon Number	Average normalized abundance of (fraction of total) n-paraffins by fuel					
	EM-238-F	EM-239-F	EM-240-F	EM-241-F	EM-242-F	Avg. No. 2
6	0.000			0.001		0
7	0.003			0.001		0.001
9	0.003			0.001		0.001
10	0.002	0.022	0.007	0.001		0.006
11	0.007			0.000	0.001	0.002
12	0.013	0.018	0.035	0.019	0.022	0.018
13	0.034		0.235	0.100		0.034
14	0.101	0.118	0.225	0.160	0.170	0.137
15	0.150	0.248	0.118	0.152	0.272	0.206
16	0.133	0.262	0.044	0.187	0.230	0.203
17	0.177	0.241	0.027	0.164	0.228	0.203
18	0.130	0.090	0.004	0.090	0.054	0.091
19	0.117		0.011	0.078		0.049
20	0.064		0.179	0.028	0.022	0.029
21	0.027			0.011		0.010
22	0.013			0.002		0.004
23	0.014			0		0.004
24	0.005		0.106	0.002		0.002
				0.002		0.001
28	0.007		0.013			0.002
32						
36						
40						
% peak data[b]	56.0	36.3	30.8	57.8	49.0	49.8

[a] by ASTM D2887-73 simulated distillation

[b] sum of paraffins as % peak by G.C.; peak area less than total sample area

TABLE 16. GAS CHROMATOGRAPH ANALYSIS[a] OF FIVE TEST FUELS

Weight % Off	Temperature in °C by fuel					
	EM-238-F	EM-239-F	EM-240-F	EM-241-F	EM-242-F	Avg. No. 2
0 (IBP)	154	118	114	132	128	133
5	196	182	144	188	183	187
10	199	200	158	206	198	201
20	212	225	174	232	218	222
40	258	258	196	264	253	258
60	284	280	217	288	280	283
80	320	314	241	321	318	318
90	341	335	260	341	336	338
95	356	350	272	354	350	352
100 (EP)	396	380	304	384	373	383

Carbon Number	Normalized abundance of (fraction of total) n-paraffins by fuel					
	EM-238-F	EM-239-F	EM-240-F	EM-241-F	EM-242-F	Avg. No. 2
9	-----	-----	0.034	-----	-----	-----
10	-----	0.016	0.141	0.006	-----	0.006
11	0.237	0.041	0.229	0.015	0.120	0.103
12	0.134	0.082	0.263	0.078	0.043	0.084
13	0.074	0.146	0.216	0.105	0.172	0.124
14	0.090	0.141	0.061	0.111	0.147	0.122
15	0.120	0.203	0.031	0.151	0.117	0.148
16	0.092	0.123	0.017	0.174	0.109	0.124
17	0.112	0.137	0.008	0.141	0.136	0.132
18	0.054	0.052	-----	0.093	0.077	0.069
19	0.032	0.028	-----	0.078	0.046	0.046
20	0.020	0.017	-----	0.030	0.024	0.024
21	0.016	0.009	-----	0.011	0.008	0.011
22	0.009	0.004	-----	0.004	-----	0.004
23	0.005	-----	-----	0.004	-----	0.002
24	0.002	-----	-----	-----	-----	-----
% peak data[b]	64.7	56.3	44.9	56.1	60.3	59.4

---

[a] by ASTM D-2887-73 simulated distillation

[b] sum of paraffins as % of peak area by GC; peak area less than total sample area

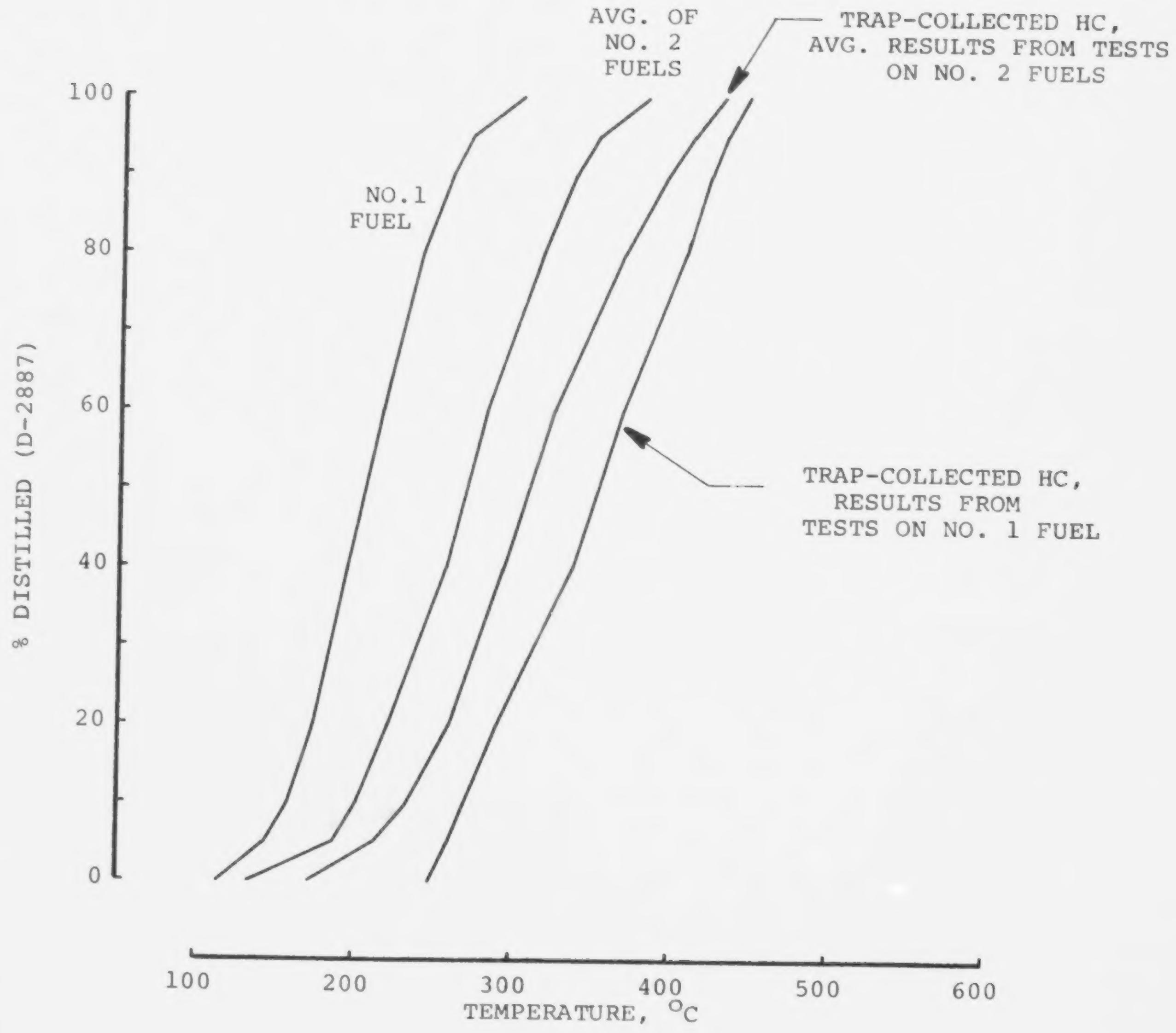

Figure 30. Boiling ranges for fuels and gaseous HC, Mercedes 240D

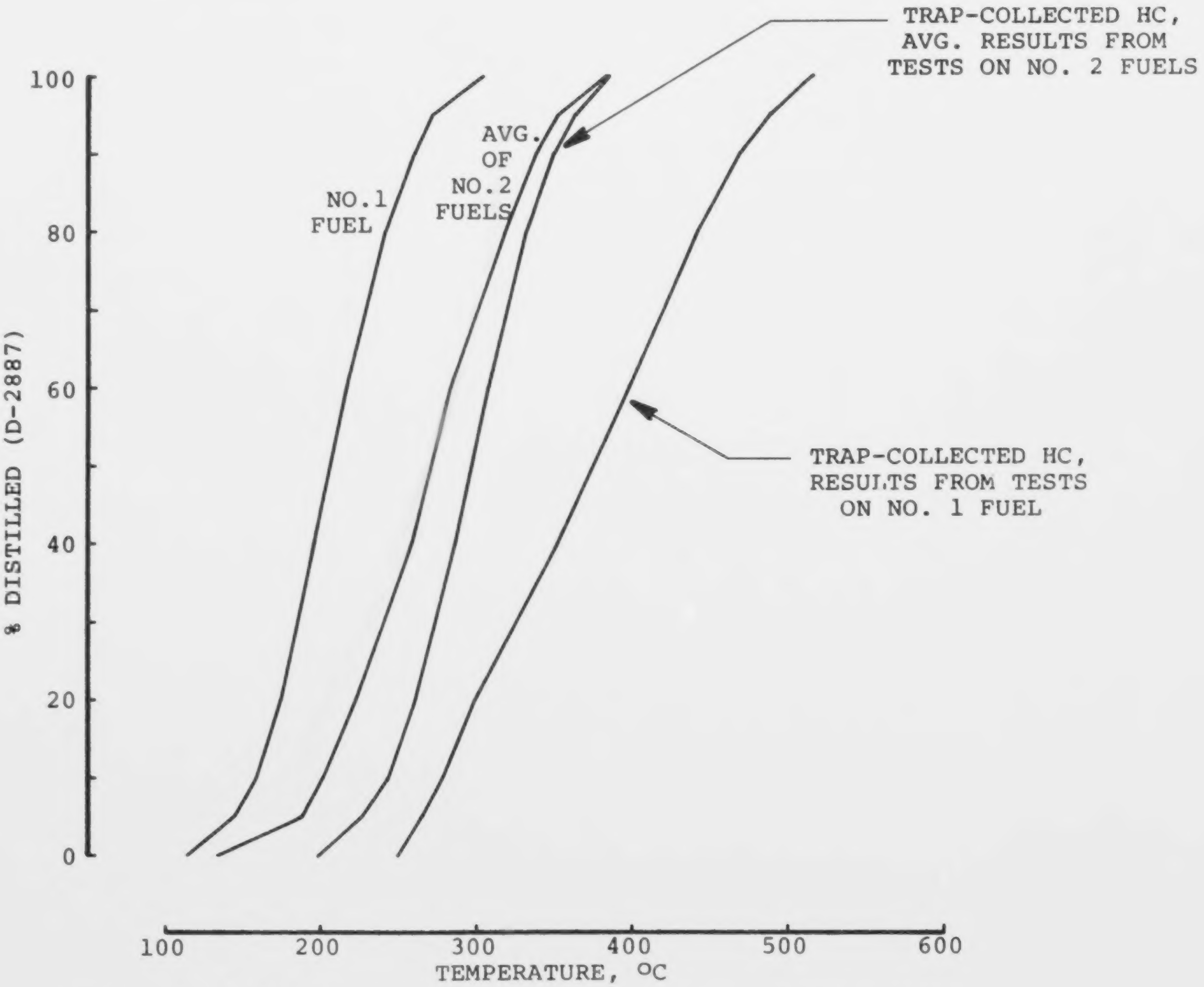

Figure 31. Boiling ranges for fuels and gaseous HC, VW Rabbit Diesel

TABLE 17. SUMMARY OF ODOR AND CORRESPONDING EMISSIONS DATA, MERCEDES 240D

		Average data values by engine rpm/% load						
Data item	Fuel	1800/2%	1800/50%	1800/100%	3000/2%	3000/50%	3000/100%	Idle
Odor panel "D" rating	EM-238-F	2.0	1.9	2.4	2.3	2.0	2.8	2.0
	EM-239-F	2.2	2.0	2.6	2.0	2.2	2.9	2.3
	EM-240-F	2.1	1.9	2.0	2.2	1.8	2.6	2.2
	EM-241-F	2.2	1.8	2.2	2.2	2.0	2.6	2.2
	EM-242-F	2.0	1.9	2.4	2.0	2.3	2.7	2.2
DOAS TIA rating	EM-238-F	1.5	1.5	1.5	1.4	1.4	1.6	1.4
	EM-239-F	1.4	1.4	1.6	1.5	1.6	1.8	1.6
	EM-240-F	1.5	1.3	1.3	1.2	1.4	1.6	1.0
	EM-241-F	1.2	1.2	1.4	1.2	1.3	1.6	1.2
	EM-242-F	1.2	1.4	1.5	1.2	1.3	1.6	1.1
Total HC by FID, ppm C	EM-238-F	56	38	33	57	38	28	80
	EM-239-F	65	40	40	60	32	38	103
	EM-240-F	48	32	29	56	30	35	60
	EM-241-F	51	34	34	49	31	30	84
	EM-242-F	58	33	33	47	30	30	78
"Total aldehydes", ppm	EM-238-F	7.6	2.2	5.6	4.0	4.7	7.2	6.0
	EM-239-F	9.4	15.0	13.0	12.4	9.4	5.2	16.3
	EM-240-F	3.6	4.9	6.3	8.0	0.8	6.4	5.7
	EM-241-F	6.8	2.5	4.8	6.2	3.8	5.2	6.1
	EM-242-F	5.0	1.6	2.7	5.9	1.1	3.3	6.6
Methane, ppm	EM-238-F	6.2	3.9	3.9	7.5	4.2	3.0	9.1
	EM-239-F	6.6	3.9	4.7	7.6	3.4	2.3	8.7
	EM-240-F	6.2	3.9	4.4	10.4	5.0	5.5	6.7
	EM-241-F	5.3	3.6	5.1	8.3	4.3	4.1	7.7
	EM-242-F	8.5	3.6	4.6	8.4	4.9	3.9	8.1
Non-methane light HC, ppm C	EM-238-F	14.7	12.1	13.6	22.6	11.3	11.9	28.3
	EM-239-F	23.0	13.5	15.8	25.8	11.3	11.8	33.4
	EM-240-F	17.0	15.7	14.0	31.2	13.4	16.6	23.7
	EM-241-F	15.6	14.4	14.8	23.3	10.6	14.4	32.6
	EM-242-F	29.0	9.1	12.9	23.4	13.5	13.7	29.5

	Odor panel "D" rating by transient operating condition			
Fuel	Idle - Acceleration	Acceleration	Deceleration	Cold Start
EM-238-F	2.8	2.5	4.2	4.0
EM-239-F	3.0	2.9	4.8	2.8
EM-241-F	2.6	2.4	4.4	2.8
EM-241-F	2.8	2.6	4.4	4.0
EM-242-F	2.5	2.5	4.0	4.1

Data on the VW Rabbit, Table 18, indicate slightly stronger odor than that recorded for the Mercedes. Both panel and instrumental data indicate that operation of EM-241-F "minimum quality" No. 2 fuel produced almost uniformly stronger odor than operation on the other fuels. Odor intensity dependence on operating condition was mixed and very weak. Higher levels of total hydrocarbons, non-methane light hydrocarbons, and aldehydes occurred most often at idle, followed by the 1800 rpm/2% load condition. Highest idle emissions of all the gaseous constituents measured were recorded during use of fuel EM-241-F, but fuel effects at other conditions were mixed. All the transient odor ratings were highest when fuel EM-241-F was in use, and the cold start produced higher overall odor levels than the other transients.

F. Other Gaseous Emissions Data

In addition to gaseous emissions data in (mass/distance) and (mass/time) already discussed, gaseous emissions results were also computed in fuel specific units (mass/kg fuel). These data are given in Appendix F as pages F-46 and F-47 (Mercedes) and F-48 and F-49 (VW), their major intended use being input in impact calculations where category fuel consumption is available.

TABLE 18. SUMMARY OF ODOR AND CORRESPONDING EMISSIONS DATA, VW RABBIT

Data item	Fuel	Average data values by engine rpm/% load						
		1800/2%	1800/50%	1800/100%	3000/2%	3000/50%	3000/100%	Idle
Odor panel "D" rating	EM-238-F	2.7	2.5	3.0	2.4	2.7	3.0	2.9
	EM-239-F	2.6	2.4	3.4	2.2	2.6	3.1	3.4
	EM-240-F	2.6	2.6	3.1	3.1	3.0	3.0	3.0
	EM-241-F	2.8	2.5	3.5	2.8	3.2	3.3	3.4
	EM-242-F	2.6	2.6	2.8	2.2	2.8	2.9	2.8
DOAS TIA rating	EM-238-F	1.8	2.0	2.2	1.5	2.1	2.1	1.7
	EM-239-F	1.7	1.9	2.2	1.5	2.1	2.0	1.8
	EM-240-F	1.6	1.8	2.0	1.7	2.0	2.0	1.5
	EM-241-F	2.2	2.2	2.4	1.9	2.4	2.3	2.2
	EM-242-F	1.5	1.6	2.0	1.4	1.9	1.9	1.4
Total HC by FID, ppm C	EM-230-F	136	84	84	64	120	58	246
	EM-239-F	138	110	136	72	180	93	314
	EM-240-F	77	63	84	400	176	80	292
	EM-241-F	152	75	86	79	120	96	625
	EM-242-F	68	78	60	43	132	58	183
"Total aldehydes", ppm	EM-238-F	23.3	16.6	9.8	8.6	3.2	15.6	40.0
	EM-239-F	7.8	5.6	13.4	2.0	10.3	6.6	25.5
	EM-240-F	12.8	5.7	9.6	2.1	8.3	14.8	3.9
	EM-241-F	21.4	24.2	2.2	12.2	8.1	10.4	52.6
	EM-242-F	12.9	8.5	13.4	4.6	9.1	5.2	33.9
Methane, ppm	EM-238-F	4.6	0	0.4	0.6	5.1	3.8	2.9
	EM-239-F	2.7	1.8	1.8	2.6	9.2	8.8	5.4
	EM-240-F	0.5	0	0	2.1	13.8	4.6	0.2
	EM-241-F	6.8	4.0	7.6	5.0	11.7	9.5	10.0
	EM-242-F	5.8	9.7	7.8	5.4	15.7	14.9	6.4
Non-methane light HC, ppm C	EM-238-F	58.8	21.2	23.7	14.0	36.4	33.6	43.0
	EM-239-F	24.9	21.4	20.2	14.6	56.8	27.0	47.7
	EM-240-F	34.9	17.9	28.4	45.5	80.9	39.1	33.5
	EM-241-F	32.9	24.3	25.1	17.6	52.3	22.0	84.0
	EM-242-F	28.6	32.7	27.0	15.0	62.1	31.1	42.9

Fuel	Odor panel "D" rating by transient operating condition			
	Idle - Acceleration	Acceleration	Deceleration	Cold Start
EM-238-F	3.6	3.7	3.0	4.1
EM-239-F	3.2	3.6	2.8	5.0
EM-240-F	3.3	3.3	3.3	4.0
EM-241-F	3.9	4.4	3.7	5.4
EM-242-F	3.4	3.8	3.0	4.8

VII. SMOKE AND PARTICULATE EMISSION RESULTS

This section of the report presents summary data and discussion on visible smoke, total particulate mass emissions, particle size distribution, sulfate, elemental composition of particulate matter, and phenols in particulate matter. In addition, it includes information on organic solubles in particulate matter, BaP in solubles, and boiling range of organic solubles by gas chromatograph analysis.

A. Visible Smoke Emissions

Visible smoke from both vehicles was measured using an EPA-type smokemeter over the first 505 seconds (the "transient phase") of the FTP, starting with both "cold" (approximately 72°F) and "hot" (within about 10 minutes following a prior test run) engine conditions. Data taken were in the form of recorder strip charts of vehicle speed and smoke opacity versus time. These charts were analyzed manually for smoke peaks and averages during the initial portion of each test, and it was found that almost all variation (fuel-to-fuel, and vehicle-to-vehicle) was contained in the first three or four minutes of operation. A summary of the smoke data is given in Table 19, based on plumes emitted through 51 mm (2 inch) O.D. exhaust pipes.

TABLE 19. SUMMARY OF SMOKE DATA BY VEHICLE AND FUEL

Vehicle	Condition	Average Smoke, PHS %, by fuel				
		238	239	240	241	242
Mercedes 240D	Cold start peak	22.	36.	39.	59.	21.
	Cold idle avg. (after start)	4.2	2.6	2.3	2.2	3.4
	1st accel peak	18.	15.	15.	14.	18.
	Idle at 125 sec, avg.	2.0	1.4	1.4	2.4	2.1
	Accel at 164 sec, peak	6.6	13.	7.2	9.8	12.
	Hot start peak	26.	38.	23.	29.	22.
	Hot idle avg. (after start)	2.2	1.4	1.4	2.3	2.3
	Hot 1st accel peak	7.0	7.8	5.8	11.	7.5
	Hot idle at 125 sec, avg.	1.8	1.7	1.3	2.2	1.8
	Hot accel at 164 sec, peak	5.4	6.2	4.6	5.2	6.2
VW Rabbit Diesel	Cold start peak	71.	79.	58.	89.	85.
	Cold idle avg. (after start)	0.5	3.0	1.8	72.	3.5
	1st accel peak	16.	5.8	6.8	41.	23.
	Idle at 125 sec, avg.	0.3	0.5	0.4	0.4	0.4
	Accel. at 164 sec, peak	18.	22.	10.	27.	22.
	Hot start peak	41.	37.	28.	48.	34.
	Hot idle avg. (after start)	0.4	0.4	0.2	0.2	0.3
	Hot 1st accel peak	3.5	3.0	2.9	4.2	2.2
	Hot idle at 125 sec, avg.	0.4	0.4	0.2	0.2	0.5
	Hot accel at 164 sec, peak	31.	23.	13.	28.	17.

The first five line items for each vehicle and fuel represent data from the cold 505, and the sixth through 10th line items represent data from the hot 505 for comparison. Starting peaks were generally much higher during cold starts than during hot starts for the VW Rabbit, but this trend held only for "minimum quality" No. 2 fuel (EM-241-F) in the Mercedes 240D. Note also that of all the first or "cold" idles, the peak for fuel EM-241-F in the VW Rabbit was highest at 72% opacity, and that this value was the only cold idle which exceeded 4.2% opacity. It appears that the relatively low-cetane fuel (cetane index(26) approximately 42) made cold operation marginal in the VW Rabbit. Some of the smoke charts (initial portion only) are shown in Appendix G, Figures G-1 through G-8 (pages G-2 through G-9). Figure G-1 shows the beginning of Run 1 (cold start) on the VW Rabbit with EM-241-F fuel; and it can be compared to Figure G-2, which shows the corresponding hot start. The high "cold idle" smoke in Figure G-1 was not repeated in the first idle of Figure G-2. Figures G-3 and G-4 show a similar comparison for the Mercedes 240D, but no substantial difference is appparent for this vehicle.

Figure G-5 shows a cold start on EM-240-F (No. 1) fuel for the VW Rabbit, and Figure G-6 shows the initial portions of a corresponding run on the Mercedes 240D. Although the No. 1 fuel (EM-240-F) produced slightly lower smoke overall, results with No. 2 fuels other than EM-241-F were quite similar to those obtained with the No. 1 fuel. This similarity can be verified by comparing Figure G-7 (VW Rabbit cold start on EM-242-F) with Figure G-6.

B. Particulate Mass Emissions and Concentrations

Total particulate emissions were measured by six simultaneous filtration systems during each test, including two each 47 mm glass fiber and Fluoro[illegible]e, one hi-vol filter, and one inertial impactor. Mass emissions computed from 47 mm glass fiber filter weights were considered most representative for characterization purposes at the time these tests were conducted, but corresponding values had to be obtained for the other collection systems in order to quantify particulate constituents. All the particulate mass emissions data are summarized in Tables 20 and 21 for the Mercedes 240D and the VW Rabbit Diesel, respectively. The minimum number of individual emission results averaged or tabulated to arrive at these data is as follows:

Sampling system(s)	Minimum individual results by operating cycle(s)		
	all FTP's	CFDS	All others
both 47 mm types	6	4	2
impactor and hi-vol	3	2	1

For tests repeated due to unusable data on one filter, the number of individual results used to compute values for Tables 20 and 21 exceeded the above minimums for the other filter types. As noted in the table sub-

TABLE 20. PARTICULATE MASS EMISSIONS FOR A MERCEDES 240D

Sampling System	Fuel	Grams particulate per kilometer by operating cycle or mode								
		Cold FTP	Hot FTP	(calculated) 1975 FTP	CFDS	FET	NYCC	Steady-states		
								Idle[a]	50 kph	85 kph
47 mm glass fiber	EM-238-F	0.335	0.324	0.329	0.261	0.212	0.680	2.99	0.150	0.196
	EM-239-F	0.319	0.311	0.314	0.226	0.192	0.565	3.16	0.142	0.165
	EM-240-F	0.251	0.223	0.235	0.166	0.140	0.317	1.50	0.114	0.136
	EM-241-F	0.408	0.358	0.380	0.257	0.258	0.808	4.00	0.150	0.231
	EM-242-F	0.299	0.286	0.292	0.203	0.181	0.563	2.71	0.131	0.195
47 mm Fluoropore	EM-238-F	0.272	0.241	0.254	0.183	0.188	0.580	2.08	0.120	0.172
	EM-239-F	0.273	0.262	0.267	0.179	0.173	0.460	1.92	0.101	0.128
	EM-240-F	0.207	0.188	0.196	0.138	0.132	0.256	1.24	0.092	0.109
	EM-241-F	0.348	0.309	0.326	0.224	0.248	0.644	2.83	0.136	0.210
	EM-242-F	0.274	0.265	0.269	0.188	0.158	0.486	2.03	0.115	0.182
Impactor set	EM-238-F	0.293	0.314	0.305	0.228	0.194	0.550	3.08	0.161	0.192
	EM-239-F	0.292	0.286	0.289	0.204	0.177	0.474	2.78	0.091	0.153
	EM-240-F	0.239	0.217	0.226	0.160	0.141	0.300	1.70	0.114	0.142
	EM-241-F	0.330	0.311	0.319	0.256	0.218	0.661	4.11	0.141	0.202
	EM-242-F	0.272	0.249	0.259	0.174	0.173	0.363	1.66	0.124	0.183
Hi-vol glass fiber	EM-238-F	0.303	0.281	0.290	0.191	0.173	0.617	2.56	0.133	0.170
	EM-239-F	0.295	0.279	0.286	0.202	0.167	0.537	2.98	0.131	0.147
	EM-240-F	0.224	0.203	0.212	0.144	0.124	0.287	1.42	0.102	0.095
	EM-241-F	0.369	0.314	0.338	0.226	0.218	0.720	3.56	0.138	0.192
	EM-242-F	0.245	0.262	0.255	0.163	0.175	0.459	2.31	0.114	0.147

[a] grams per hour instead of grams per kilometer

TABLE 21. PARTICULATE MASS EMISSIONS FOR A VW RABBIT DIESEL

		Grams particulate per kilometer by operating cycle or mode								
		Cold	Hot	(calculated)				Steady-states		
Sampling System	Fuel	FTP	FTP	1975 FTP	CFDS	FET	NYCC	Idle[a]	50 kph	85 kph
47 mm glass fiber	EM-238-F	0.252	0.204	0.225	0.206	0.173	0.363	1.93	0.090	0.167
	EM-239-F	0.250	0.194	0.218	0.194	0.143	0.384	2.12	0.068	0.148
	EM-240-F	0.209	0.152	0.177	0.149	0.138	0.295	0.742	0.047	0.103
	EM-241-F	0.565	0.231	0.375	0.222	0.174	0.450	2.84	0.197	0.189
	EM-242-F	0.221	0.174	0.194	0.156	0.175	0.402	2.10	0.052	0.164
47 mm Fluoropore	EM-238-F	0.204	0.156	0.177	0.198	0.150	0.219	0.838	0.060	0.137
	EM-239-F	0.202	0.147	0.171	0.163	0.114	0.218	0.812	0.040	0.130
	EM-240-F	0.160	0.104	0.128	0.095	0.130	0.176	0.244	0.024	0.066
	EM-241-F	0.962[b]	0.174	0.513	0.199	0.140	0.225	1.64	0.103	0.197
	EM-242-F	0.186	0.149	0.165	0.148	0.154	0.200	0.424	0.037	0.151
Impactor set	EM-238-F	0.221	0.173	0.194	0.187	0.137	0.294	1.57	0.078	0.156
	EM-239-F	0.222	0.178	0.197	0.174	0.140	0.322	1.94	0.066	0.147
	EM-240-F	0.190	0.144	0.164	0.148	0.128	0.232	0.711	0.053	0.102
	EM-241-F	0.486	0.210	0.329	0.190	0.142	0.438	3.64	0.196	0.175
	EM-242-F	0.181	0.152	0.164	0.118	0.151	0.325	1.92	0.030	0.153
Hi-vol glass fiber	EM-238-F	0.223	0.182	0.200	0.194	0.150	0.290	1.58	0.066	0.144
	EM-239-F	0.206	0.168	0.184	0.165	0.127	0.296	1.58	0.055	0.136
	EM-240-F	0.181	0.136	0.155	0.130	0.110	0.252	0.715	0.042	0.086
	EM-241-F	0.432	0.191	0.295	0.189	0.151	0.360	2.48	0.114	0.158
	EM-242-F	0.190	0.150	0.167	0.136	0.154	0.276	----[c]	0.041	0.131

[a] grams per hour instead of grams per kilometer
[b] difficulties were encountered with filter plugging
[c] no data

headings, the 1975 FTP entries were calculated from corresponding cold and hot FTP data. Data given for 47 mm glass fiber filters are repeated in Appendix G, pages G-10 (Mercedes) and G-13 (VW). Tables 20 and 21 show that vehicle, operating condition, particulate collection system, and fuel type all influenced particulate mass emissions. Most of the corresponding results for the two vehicles show higher emissions for the Mercedes than for the VW, with the notable exception of cold start FTP tests on EM-241-F fuel, which was uniformly higher for the VW Rabbit Diesel. For both vehicles and most operating conditions, lowest particulate emissions per unit distance traveled occurred when EM-240-F No. 1 fuel was in use. Highest emissions generally occurred using EM-241-F "minimum quality" No. 2 fuel.

Operating conditions influenced particulate emissions from both vehicles quite strongly. Cold start FTP emissions were also uniformly higher than hot start FTP emissions, with small differences the rule for the Mercedes (average about 7%) and larger differences for the VW (average about 30%). It also appears that higher road speed (with its corresponding higher power requirement), greater fractions of idle time, and greater speed variability all contributed to higher particulate emissions.

Particulate emissions data are given in grams per hour for all operating conditions in Table 22, based only on 47 mm glass fiber filter results. This information is also included in the complete data set for statistical analysis in Appendix G, pages G-15 (Mercedes) and G-19 (VW). The fuel-to-fuel and vehicle-to-vehicle comparisons in Table 22 show the same trends as those in Tables 20 and 21, but the comparisons between conditions are quite different. Time-based emissions show idle to be lowest on this basis, with the other conditions producing higher emissions roughly proportional to their average speeds. Other parameters of the operating conditions are also important, such as speed variability, percent of idle time, and so forth.

Particulate concentrations were calculated only from 47 mm glass fiber filter data, although the method outlined in section V would work as well for any of the collection systems. The concentration data are given in Table 23 for both vehicles, and this information can also be found in Appendix G, pages G-10 (Mercedes) and G-13 (VW). Trends in concentration between fuels and operating conditions are the same as those for particulate mass emissions, but those between vehicles are slightly different due to the effects of differing exhaust rates. These effects show up as an increased number of conditions under which the VW concentrations equal or exceed the Mercedes concentrations as compared to particulate mass emissions data.

Concentration values in Table 23 also permit direct comparison of idle emissions with those at other operating conditions, in this case, without consideration of exhaust flow rates. Both vehicles exhibited comparatively low particulate concentrations at idle when EM-240-F No. 1 fuel was used. When No. 2 fuels were in use, particulate concentrations were more nearly equal to those emitted at other operating conditions.

TABLE 22. TIME-BASED PARTICULATE EMISSIONS FOR TWO DIESEL VEHICLES[a]

Vehicle	Fuel	Grams particulate per hour by operating cycle or mode								
		Cold FTP	Hot FTP	(calculated) 1975 FTP	CFDS	FET	NYCC	Steady-states		
								Idle	50 kph	85 kph
Mercedes 240D	EM-238-F	10.5	10.2	10.4	14.6	16.4	7.73	2.99	7.50	16.7
	EM-239-F	10.0	9.78	9.88	12.6	14.9	6.42	3.16	7.10	14.0
	EM-240-F	7.90	7.02	7.39	9.29	10.9	3.60	1.50	5.70	11.6
	EM-241-F	12.8	11.3	12.0	14.4	20.0	9.19	4.00	7.50	19.6
	EM-242-F	9.41	9.00	9.19	11.4	14.0	6.40	2.71	6.55	16.6
VW Rabbit diesel	EM-238-F	7.93	6.42	7.08	11.5	13.4	4.13	1.93	4.50	14.2
	EM-239-F	7.86	6.10	6.86	10.9	11.1	4.37	2.12	3.40	12.6
	EM-240-F	6.58	4.78	5.57	8.34	10.7	3.35	0.742	2.35	8.76
	EM-241-F	17.8	7.27	11.8	12.4	13.5	5.12	2.84	9.85	16.1
	EM-242-F	6.95	5.47	6.10	8.73	13.6	4.57	2.10	2.60	13.9

[a] based on data from 47 mm filter samples

TABLE 23. PARTICULATE CONCENTRATIONS FOR TWO DIESEL VEHICLES

Vehicle	Fuel	Particulate concentration in mg/m^3 by operating cycle or mode[a]								
		Cold FTP	Hot FTP	(calculated) 1975 FTP	CFDS	FET	NYCC	Steady-States		
								Idle	50 kph	85 kph
Mercedes 240D	EM-238-F	104.	103.	103.	115.	113.	140.	90.6	81.9	103.
	EM-239-F	99.5	98.5	98.9	99.7	102.	116.	95.8	77.5	87.0
	EM-240-F	78.3	70.6	73.9	73.2	74.4	65.3	45.4	62.2	71.7
	EM-241-F	127.	113.	119.	113.	137.	166.	121.	81.9	122.
	EM-242-F	93.3	90.6	91.7	89.5	96.2	116.	82.1	71.5	103.
VW Rabbit diesel	EM-238-F	86.9	75.1	80.2	105.	105.	86.6	49.5	56.9	102.
	EM-239-F	86.2	71.4	77.8	98.8	86.6	91.6	54.4	43.0	90.1
	EM-240-F	72.1	55.9	62.9	75.9	83.6	70.4	19.	29.7	62.7
	EM-241-F	195.	85.0	132.	113.	105.	107.	72.8	125.	115.
	EM-242-F	76.2	64.0	69.2	79.4	106.	95.9	53.8	32.9	99.8

[a] at 101.3 kPa and 21°C

C. Particle Size Distributions

All the samples for particle size analysis were collected in an inertial impactor. Impactor collection discs were simply weighed to obtain aerodynamic size distributions by mass via the impactor's own calibration, and a few impaction zones were later subjected to SEM and TEM analysis to study the apparent size distributions within the zones. Figure 32 shows an entire zone of impacted particulate on a stainless steel surface at 100x by SEM, and Figure 33 shows a small portion of an impaction zone at 10,000x by SEM. The "fluffy" appearance of the particulate matter at 10,000x became more pronounced as magnification was increased, making the SEM micrographs essentially useless for sizing purposes.

Figure 34 shows a sample of particulate matter collected on a copper grid by TEM at 21,600x, and Figure 35 shows smaller portion of this same grid (indicated by brackets in Figure 34) enlarged to 87,500x. Micrographs such as these were analyzed visually using the templates shown in an earlier section of the report (Figure 27). It was considered necessary to size agglomerates in areas where their distribution was sparse enough to avoid large concentrations which could fill an entire micrograph or introduce problematic three-dimensional effects, but this choice may have been responsible for biasing the TEM results toward small agglomerate sizes. In other words, the "monolayer" areas examined may be only those covered by agglomerates flying off the main impaction zone and redepositing further from its center.

1. Impactor Data

Data from 125 impactor runs were analyzed, including individual run and average percentages of particulate mass by stage and cumulative percentages of particulate mass by stage, for the entire data set and a number of subsets. The subsets included individual fuels, operating cycles/conditions, and vehicles, as well as individual vehicle-cycle combinations and vehicle-fuel combinations. Basic statistics were computed for the data set and all the subsets, including mean, standard deviation, and coefficient of variation. The most basic data set (mass percent collected by stage, individual runs) is given in Appendix G, pages G-22 through G-24. The run code at left on these pages represents (in order) vehicle (M or V), fuel (numerical), and test procedure. The "total particulate" column at the right on pages G-22 through G-24 is total collected mass for disc and filter in milligrams. Stage 9 was the filter stage.

A first analytical look at some of these data is given in Table 24, which includes breakdowns of mass percent collected on each stage by vehicle, by fuel, and by operating cycle or condition. These data show little difference between vehicles, and only a slight difference between fuel EM-238-F and the other fuels which shows up most strongly in filter-collected particulate (stage 9). Greater differences exist between corresponding data for the various operating schedules, with the lower-speed, higher-variability schedules (e.g. cold FTP) apparently showing

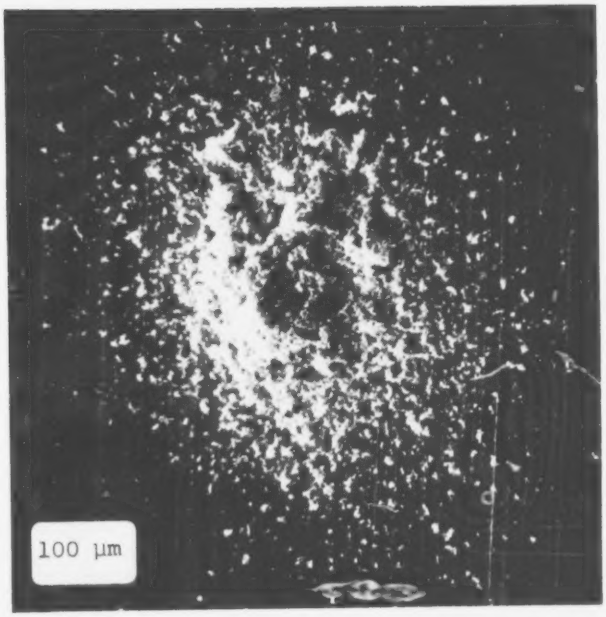

Figure 32. Impaction zone on stainless disc by SEM at 100x

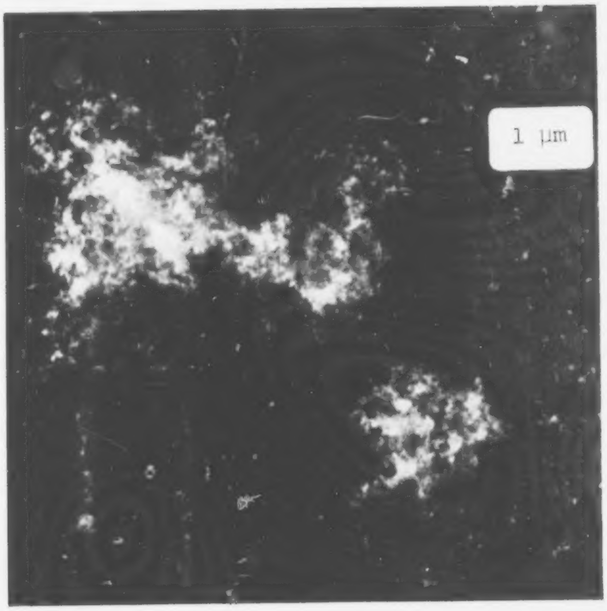

Figure 33. Portion of impaction zone on stainless disc by SEM at 10,000x

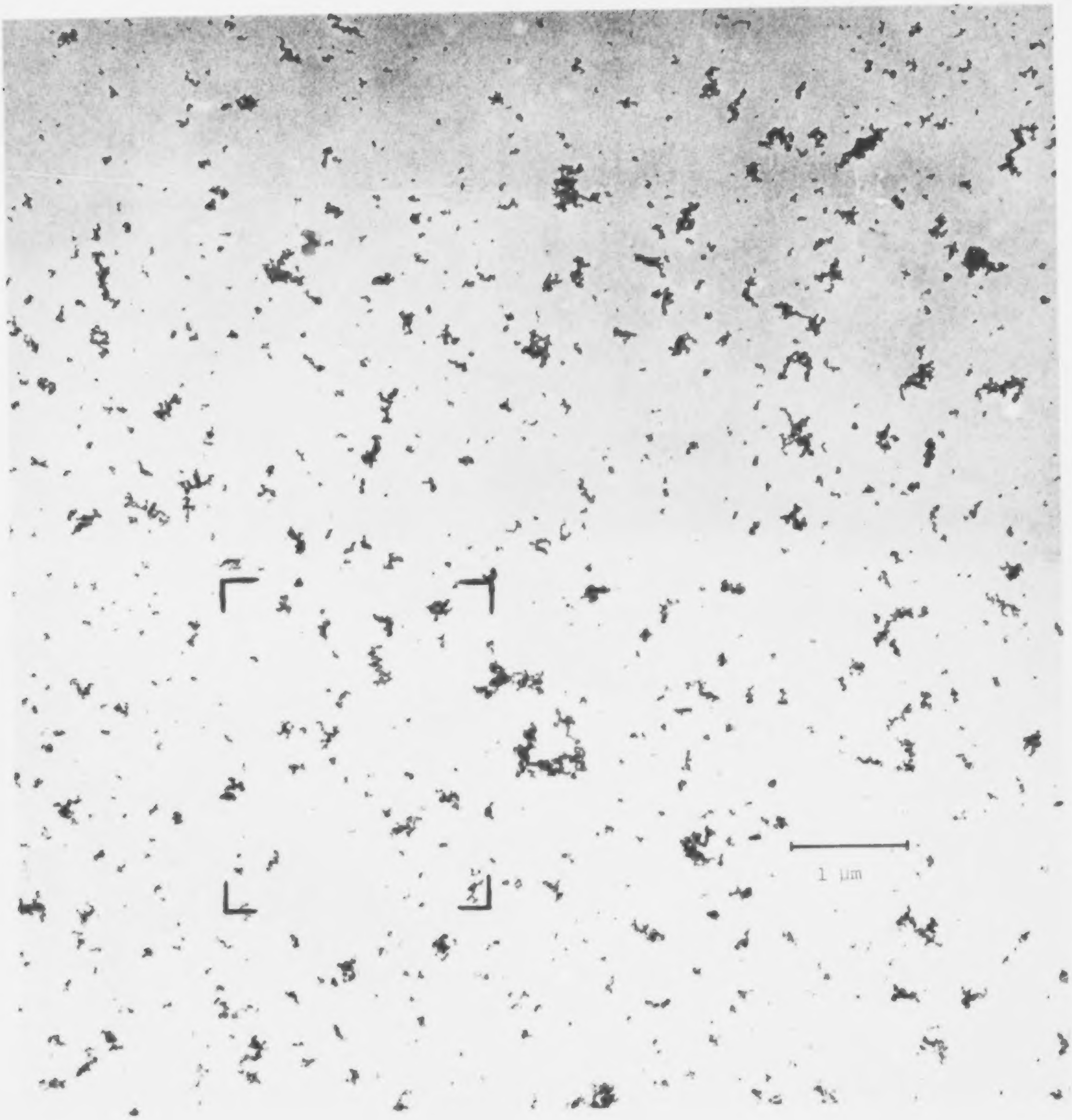

Figure 34. TEM micrograph at 21,600x

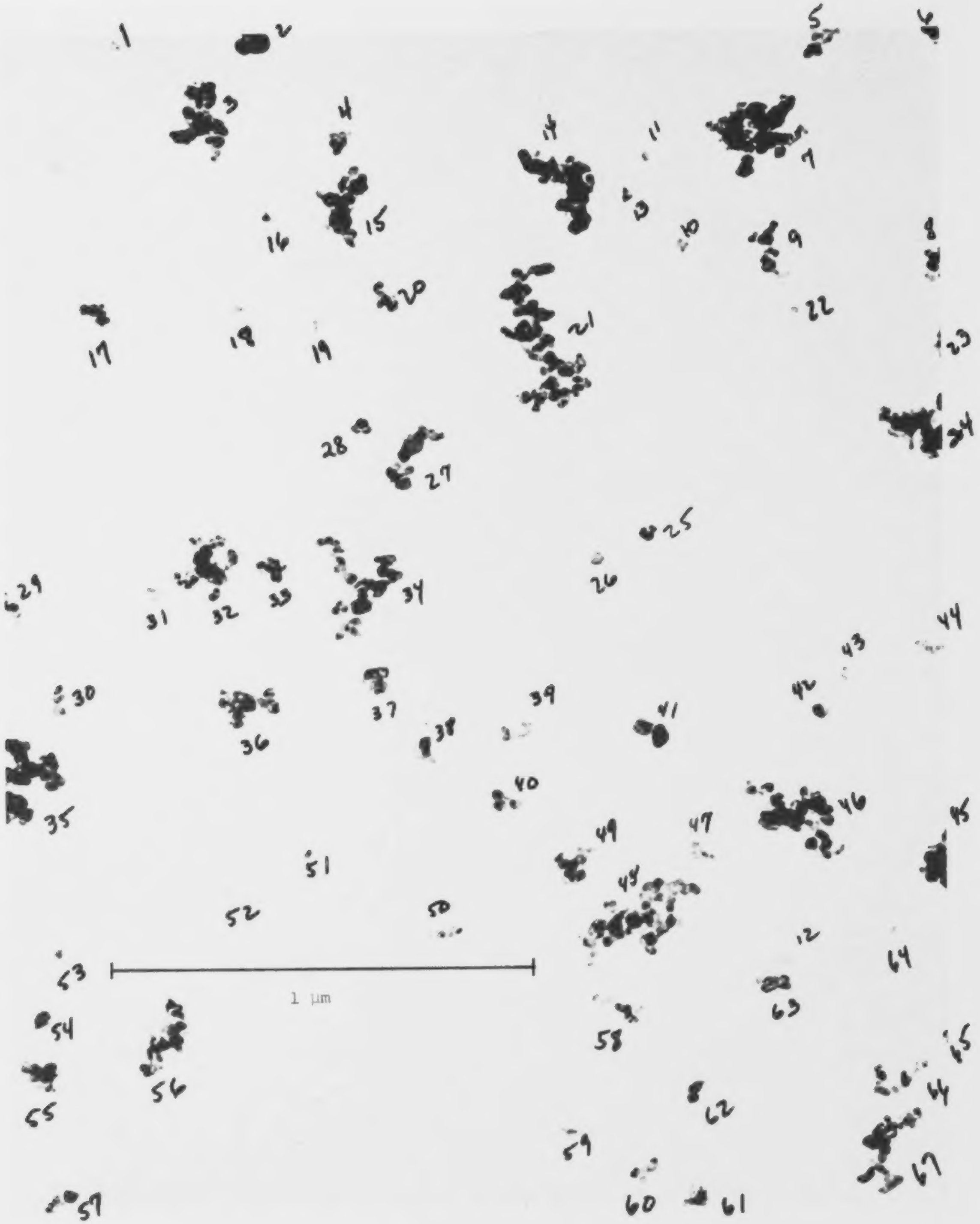
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Figure 35. TEM micrograph at 87,500x

TABLE 24. ANALYSIS OF PARTICLE SIZE DISTRIBUTION DATA FROM INERTIAL IMPACTOR TESTS

Stage	ECD, µm	Average ($\bar{x}$) and Coefficient of Variation ($s/\bar{x}$) for % Collected by Stage													
		Mercedes		Volkswagen		EM-238-F		EM-239-F		EM-240-F		EM-241-F		EM-242-F	
		$\bar{x}$	$s/\bar{x}$	$\bar{x}$	$s/\bar{x}$	$\bar{x}$	$s/\bar{x}$	x	$s/\bar{x}$	$\bar{x}$	$s/\bar{x}$	$\bar{x}$	$s/\bar{x}$	$\bar{x}$	$s/\bar{x}$
9(filter)	<0.42	83.9	0.05	83.2	0.09	80.8	0.08	84.9	0.07	84.1	0.08	83.7	0.06	83.9	0.07
8	0.42	3.7	0.25	3.0	0.44	3.5	0.33	3.1	0.24	2.9	0.28	3.7	0.43	3.5	0.37
7	0.63	3.3	0.24	2.6	0.48	3.6	0.26	3.0	0.39	2.6	0.30	2.7	0.43	3.0	0.39
6	1.02	2.9	0.32	3.0	0.59	3.5	0.46	2.8	0.47	2.8	0.55	2.6	0.44	2.9	0.42
5	2.0	2.0	0.38	2.2	0.64	2.5	0.43	2.1	0.64	2.2	0.56	1.8	0.48	1.9	0.57
4	3.2	1.6	0.58	2.0	0.61	2.0	0.60	1.5	0.61	1.8	0.65	1.9	0.60	1.7	0.60
3	4.6	1.4	0.61	2.1	0.69	2.2	0.72	1.3	0.73	1.8	0.71	1.9	0.69	1.7	0.57
2	6.8	0.7	0.64	1.2	0.92	0.9	0.73	0.8	0.93	1.2	1.19	0.9	0.50	1.0	0.68
1	11.	0.5	1.07	0.7	0.77	1.0	0.69	0.5	0.67	0.5	1.30	0.7	0.85	0.5	0.95

Stage	ECD, µm	Average ($\bar{x}$) and Coefficient of Variation ($s/\bar{x}$) for % Collected by Stage															
		Cold FTP		Hot FTP		CFDS		FET		NYCC		Idle		50 kph		85 kph	
		$\bar{x}$	$s/\bar{x}$	$\bar{x}$	$s/\bar{x}$	$\bar{x}$	$s/\bar{x}$	$\bar{x}$	$s/\bar{x}$	$\bar{x}$	$s/\bar{x}$	$\bar{x}$	$s/\bar{x}$	$\bar{x}$	$s/\bar{x}$	$\bar{x}$	$s/\bar{x}$
9(filter)	<0.42	77.6	0.04	82.1	0.05	80.0	0.05	86.0	0.03	77.9	0.08	85.7	0.07	90.9	0.03	89.0	0.02
8	0.42	4.1	0.36	3.3	0.28	3.8	0.19	3.6	0.28	3.4	0.37	3.2	0.62	2.8	0.28	3.2	0.25
7	0.63	3.7	0.14	3.0	0.20	3.8	0.21	2.8	0.29	3.0	0.30	2.4	0.72	1.8	0.40	2.8	0.29
6	1.02	4.2	0.17	3.4	0.25	3.9	0.24	2.6	0.14	3.8	0.43	1.6	0.67	1.4	0.46	2.0	0.24
5	2.0	3.1	0.21	2.5	0.32	2.7	0.26	1.7	0.25	3.0	0.49	1.6	0.59	0.9	0.59	1.0	0.29
4	3.2	2.8	0.25	2.1	0.26	2.2	0.34	1.3	0.31	3.0	0.29	1.6	0.80	0.6	0.73	0.7	0.27
3	4.6	2.9	0.19	2.0	0.36	2.2	0.39	1.8	0.75	2.8	0.58	1.0	0.69	0.5	0.77	0.6	0.23
2	6.8	1.1	0.48	0.9	0.47	0.8	0.36	0.4	0.70	1.8	0.59	1.7	0.91	0.6	1.02	0.4	0.55
1	11.	0.6	0.35	0.6	0.67	0.4	0.71	0.4	0.91	1.1	0.71	1.2	0.76	0.6	0.91	0.2	0.91

greater concentrations of larger agglomerates than the higher-speed, lower-variability schedules (e.g. 85 kph steady-state). This effect is likely due to the influence of transients in the operating schedule and the final dilution and sampling temperatures (temperatures lower for low-speed, high-variability schedules and idle). Note that all the data show between 77 and 91 percent of the particulate on stage 9 (the filter), indicating that the impactor did not adequately size the vast majority of the agglomerates. Computer printout of average run data and computed statistics for all the data sets summarized in Table 24 are given in Appendix G, pages G-25 through G-33.

Data such as those presented in Table 24 can also be expressed in cumulative mass percent of particulate smaller than stage cutoff diameters, beginning with stage 9 (filter) and working through the sampler toward larger agglomerate diameters. Computer printout of average cumulative run data and accompanying statistics are given in Appendix G, pages G-34 through G-42. To provide better comparisons and data visualization, the average run data have been plotted in Figures 36 and 37 (individual stage collection percentages, excluding stage 9) and the average cumulative run data have been plotted in Figures 38 through 40.

Figure 36 shows that as an overall average, a little more material was classified in the larger size ranges (stages 1-5) for the VW than for the Mercedes. Slightly less particulate matter was collected on stages 7 and 8 for the VW than for the Mercedes. Fuel comparisons in Figure 36 show little of significance. Figure 37 shows than comparatively slow, highly variable operating schedules (such as the cold FTP and NYCC) were associated with higher production of larger agglomerates than higher speed steady-states. These differences appear most significant for stages 3 through 6.

The average cumulative plots in Figures 38 through 40 are indicative of the overall strong similarity between impactor-derived size distributions for all the data subsets. Plots for the two vehicles in Figure 38 are hardly separable, as are those for the five fuels in Figure 39. Figure 40 shows a wider range for the eight operating schedules, with a trend toward more large agglomerates as schedule average speed decreases and speed variability increases (generally right-to-left on the graph).

2. Transmission electron microscope (TEM) data

Impactor discs were prepared for two special tests by attaching small grids (described in Section V) for later TEM analysis. These tests were both conducted on the VW Rabbit Diesel with EM-239-F ("National Average" No. 2) fuel, and consisted of one cold FTP and one 85 km/h steady-state. Four zones on each collection grid were examined by micrographs at 21,600x for comparatively large agglomerates (over 1.0 μm), and four smaller areas on each of 16 of the above-mentioned micrographs were examined at 87,500x for smaller agglomerates. Two diameters were measured for each agglomerate;

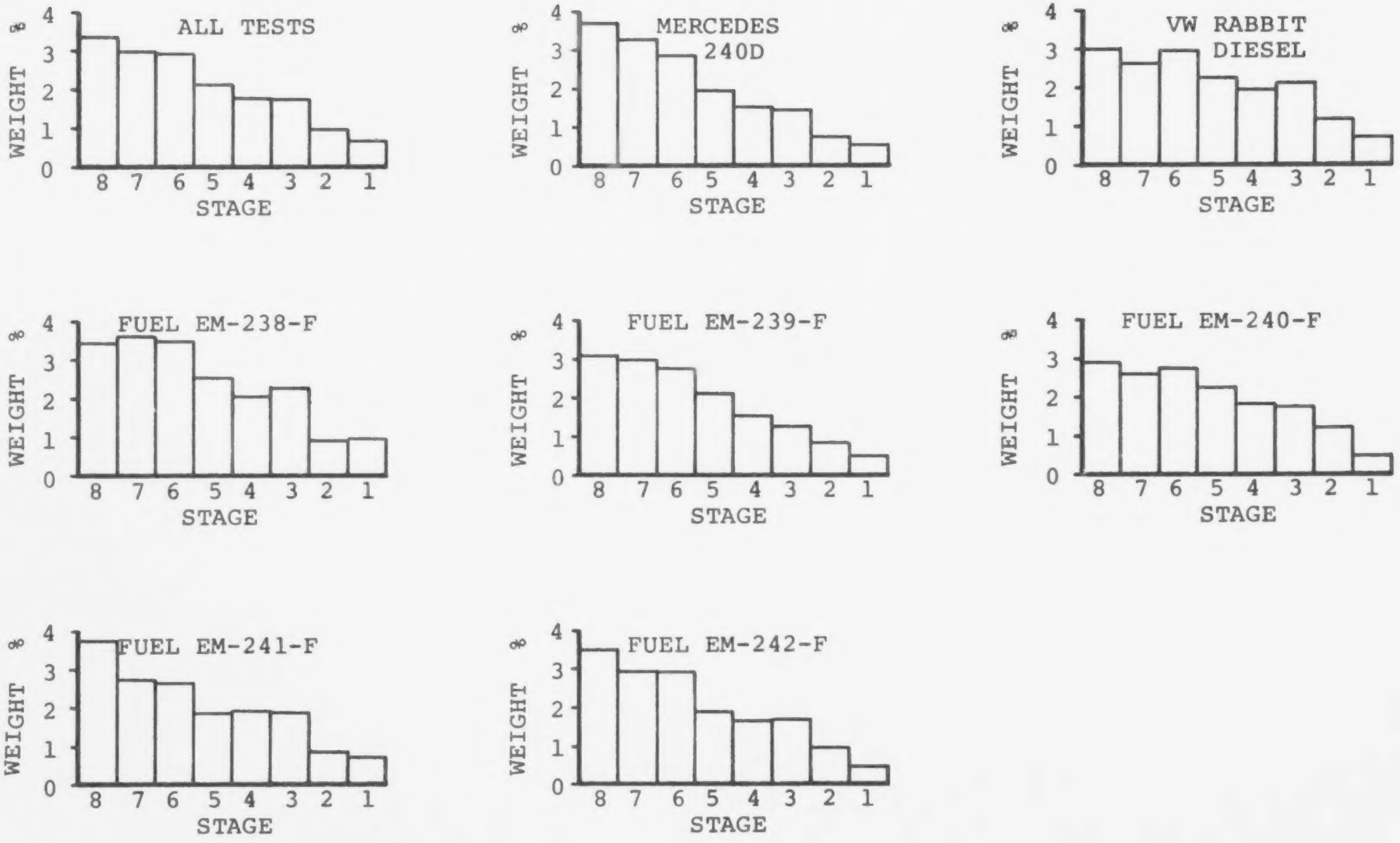

Figure 36. Average weight percentages of particulate matter by impactor stage, vehicle, and fuel

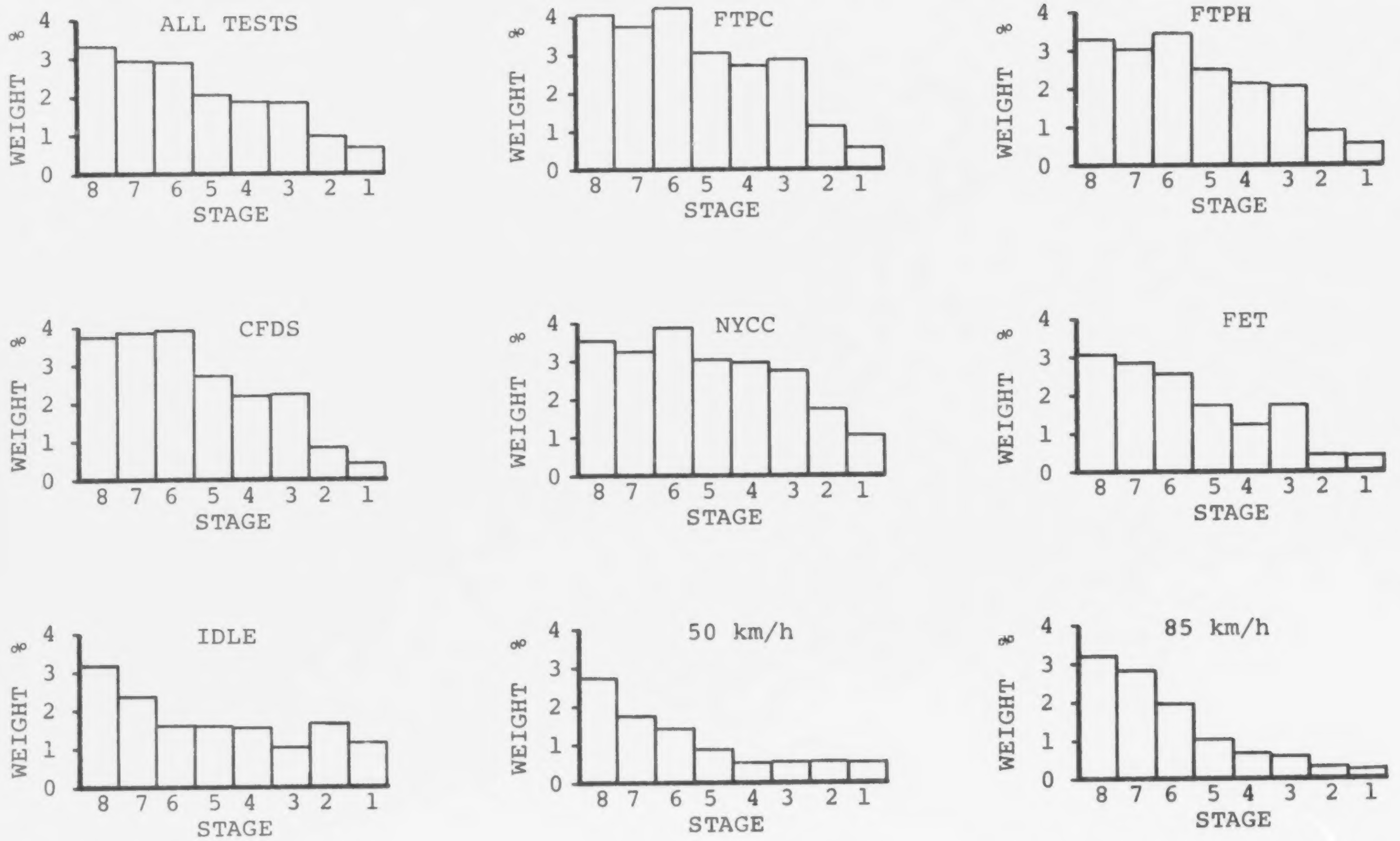

Figure 37. Average weight percentage of particulate matter collected by impactor stage and operating schedule

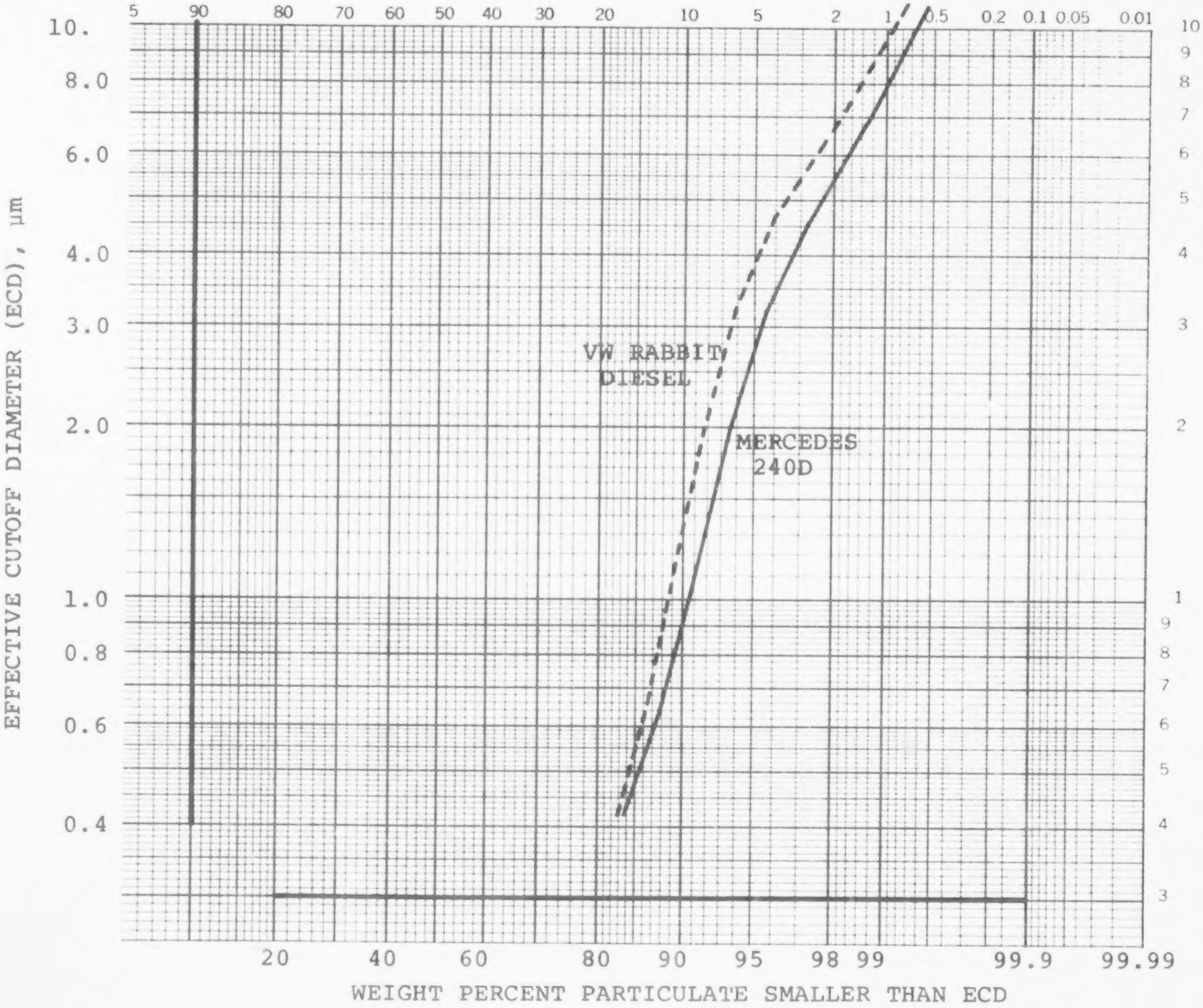

Figure 38. Average cumulative particle size distribution by impactor, two vehicles

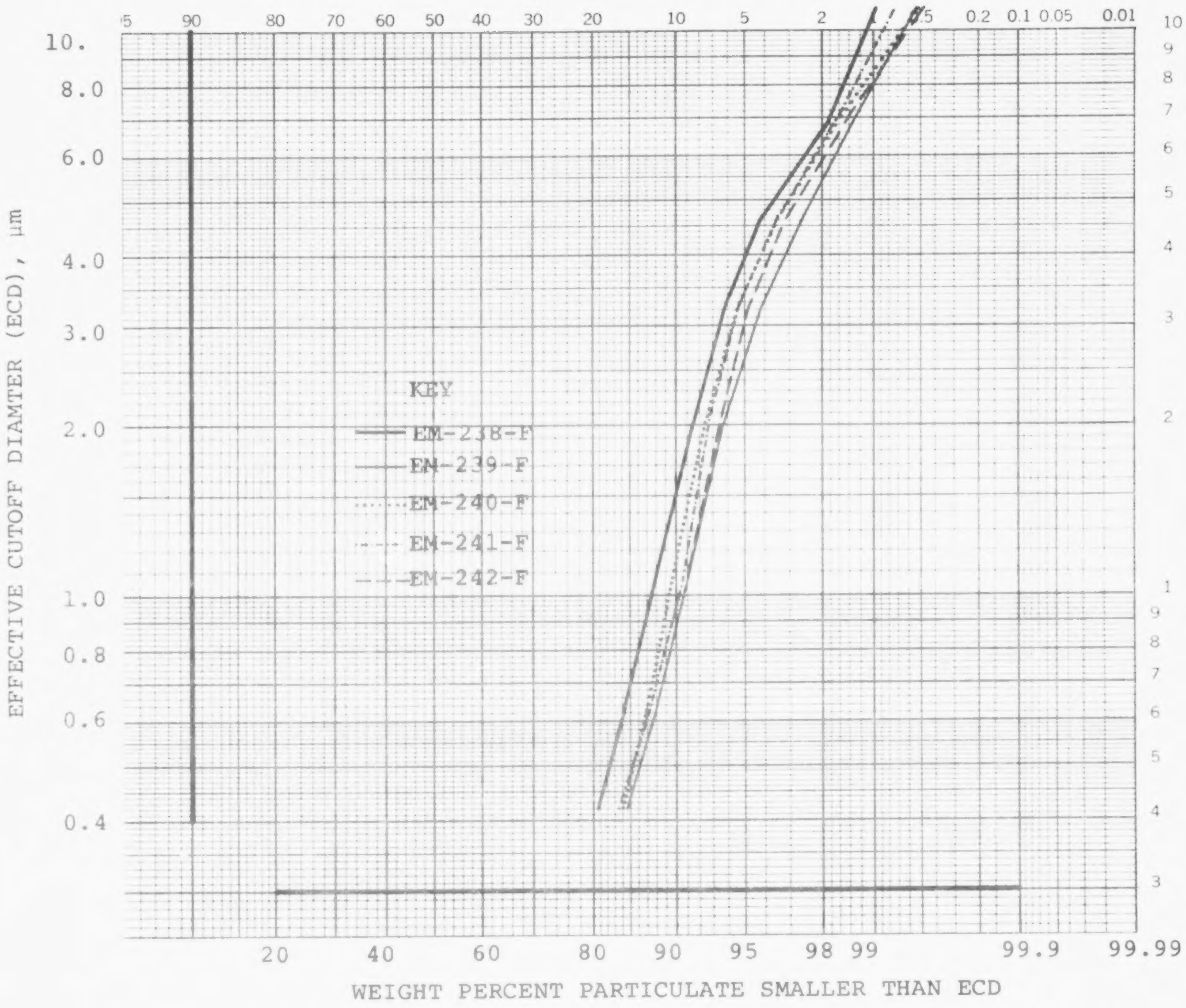

Figure 39. Average cumulative particle size distribution by impactor, five fuels

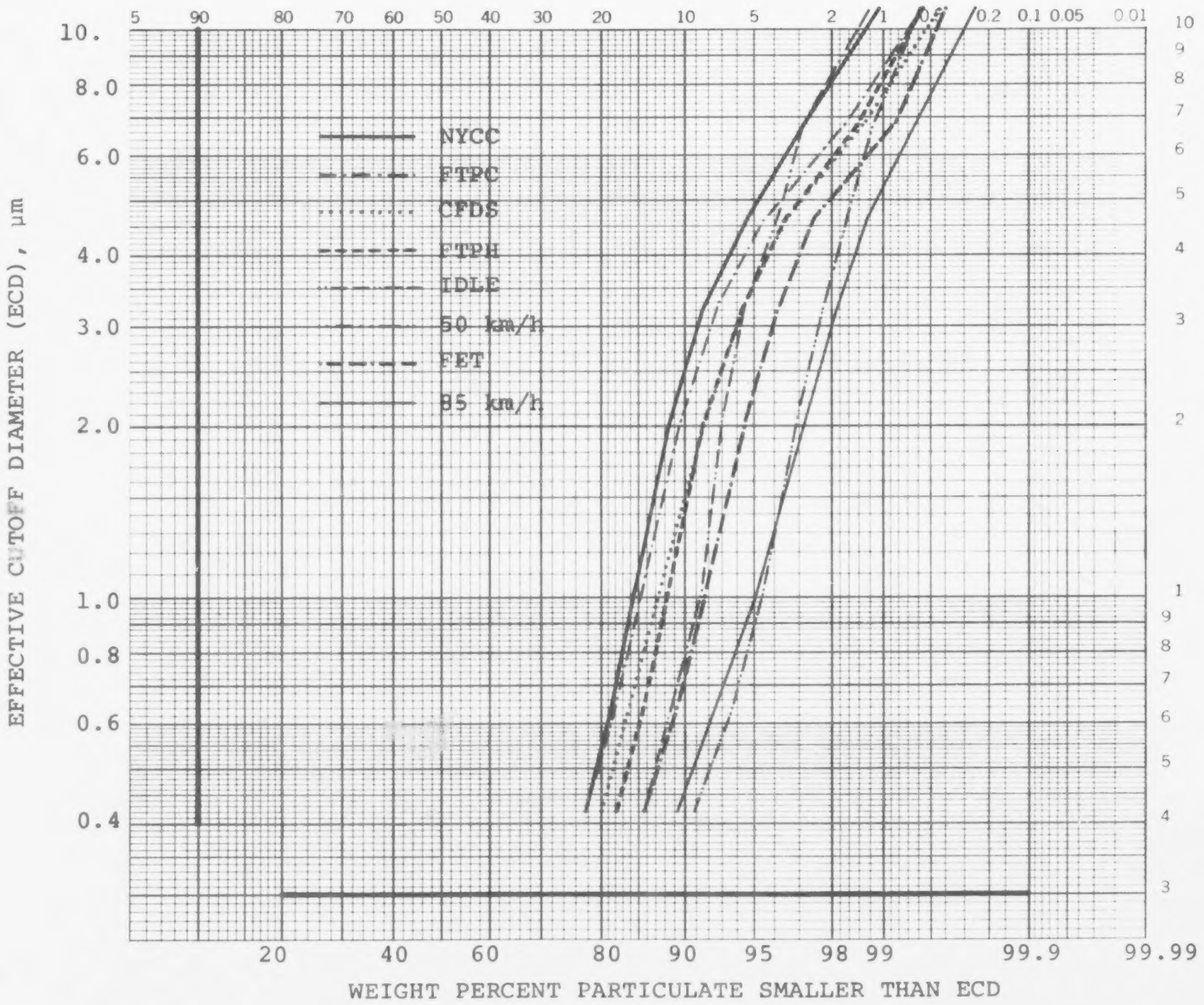

Figure 40. Average cumulative particle size distribution by impactor, eight operating schedules

the "major" diameter of a circle required to enclose it, and the "minor" diameter or "minimum chord" equal to the smallest distance between parallel lines on opposite sides of the agglomerate. The data gathered from this analysis are summarized in Table 25, and it is obvious that in all cases most of agglomerates measured 0.15 μm diameter or less. This observation indicates that for the particles sampled and the impaction zones examined, aerodynamic size distribution and physical size distribution were grossly different.

To extract more information from these data, they have been retabulated in average cumulative numerical percentages for presentation as Table 26. The cumulative data show that the 80th percentile agglomerate is uniformly smaller than 0.15 μm major diameter, that the 95th percentile agglomerate is uniformly smaller than 0.4 μm major diameter, and that (see note a) 99.95% of the agglomerates are smaller than 1.0 μm major diameter. In addition, there seems to be no trend in observed agglomerate sizes from stage to stage in the sampler. This effect may be due to the areas chosen for analysis, e.g., those areas where space between agglomerates was adequate for counting purposes, and the comparatively large sampling times used for collection.

Due to the general absense of trends in the data from Table 26, it is sufficient to present one graph showing the range of observed agglomerate size distribution on all eight discs from both test runs. This graph is given as Figure 41, and it can be compared with the average cumulative plots in Figures 38 through 40 for the purpose of contrasting impactor cumulative mass data with TEM cumulative number data. This comparison generally shows that agglomerates observed by TEM on all the discs had similar numerical size distributions, and that the numerical 90th percentile agglomerate major diameter was between 0.10 and 0.23 μm. These figures are quite different from the aerodynamic equivalent 90th percentile particle diameter range from 0.4 to 2.6 μm (from data for the VW Rabbit Diesel, FTPC and 85 km/h tests).

Recognizing that the TEM-derived agglomerate size distribution did not vary a great deal from stage to stage or from one sample tc the other, some additional consideration has been given to interpretation of the TEM data in units other than numbers of agglomerates. If the agglomerates were considered to be planar, their masses would vary approximately as the square of their diameters. This approximation, using the major diameters as basis, is probably as accurate as any other simple assumption. While it is obvious that the entire square formed by sides equal in length to the major diameter is not covered by particles in the typical agglomerate sized (see Figures 34 and 35), there are about enough additional "unseen" particles in the 3rd dimension (normal to the micrograph) to make up the difference. According to this approximation, then, agglomerate mass is roughly proportional to the square of the major diameter.

Average cumulative numerical TEM-derived major diameter data for all stages and both runs are given in column 2 of Table 27, followed by a "mass

TABLE 25. SUMMARY OF AGGLOMERATE SIZE DATA FROM TEM MICROGRAPHS

Agglomerate diameter less than (µm)	Average numerical percent counted by diameter[a]															
	stage 8, ECD 0.42		stage 7, ECD 0.63		stage 6, ECD 1.02		stage 5, ECD 2.0		stage 4, ECD 3.2		stage 3, ECD 4.6		stage 2, ECD 6.8		stage 1, ECD 11.	
	maj.	min.	maj.	min.	maj.	min.	maj.	min.	maj.	min.	maj.	min.	maj.	min.	maj.	min.
Operating schedule: Cold FTP																
0.02	27.3	47.3	32.2	48.3	30.5	46.2	32.3	44.9	12.8	19.4	30.5	33.3	23.5	33.9	32.5	45.5
0.05	36.5	32.8	32.8	36.1	33.6	34.6	27.8	35.1	17.9	37.8	12.1	20.7	25.5	32.8	30.8	32.8
0.10	21.1	12.0	24.7	10.5	22.6	12.9	24.6	13.0	32.7	30.6	20.1	28.2	27.5	24.4	22.0	16.4
0.15	4.9	4.2	3.6	3.6	4.7	3.5	5.3	5.0	20.4	7.1	14.4	8.6	12.9	5.9	7.8	3.0
0.20	5.6	2.2	4.3	1.1	3.8	1.3	3.5	0.5	4.1	2.6	10.3	2.9	4.5	2.5	1.5	1.5
0.30	3.4	1.5	1.5	0.4	2.8	1.6	3.3	1.0	9.2	2.0	6.9	4.6	5.9	0.6	4.3	0.5
0.40	0.7	----	0.6	----	1.6	----	2.5	0.5	2.6	0.5	4.0	0.6	----	----	0.5	0.3
0.50	0.5	----	0.2	----	0.3	----	----	---	----	----	0.6	1.1	0.3	----	0.3	----
0.60	----	----	----	----	----	----	0.2	----	0.5	----	----	----	----	----	0.3	----
0.80	----	----	----	----	----	----	0.5	----	----	----	1.1	----	----	----	----	----
1.0	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Agglomerates Counted	408		466		318		399		196		174		357		396	
Operating schedule: 85 km/h steady-state																
0.02	18.6	28.4	27.9	43.5	18.7	36.6	20.3	39.6	12.2	28.3	20.6	32.5	19.1	40.3	13.9	31.4
0.05	20.4	34.4	32.6	37.5	34.5	39.9	38.8	38.8	27.6	40.8	26.9	43.5	42.4	39.4	28.7	37.2
0.10	31.7	28.4	26.2	14.3	29.0	16.6	25.2	15.7	34.8	19.4	32.5	18.7	22.0	14.4	31.1	18.9
0.15	16.5	3.8	8.3	3.0	7.1	5.0	7.3	3.3	10.3	7.2	11.6	4.0	9.7	2.1	11.5	8.1
0.20	5.1	1.8	2.7	1.0	6.3	1.3	3.8	1.6	6.6	2.8	5.0	0.8	1.7	2.5	6.1	2.7
0.30	4.8	2.4	1.7	0.7	3.4	0.2	3.0	0.8	6.0	0.9	3.2	0.3	3.8	1.3	6.8	1.0
0.40	2.4	0.3	0.7	----	0.4	0.2	1.1	0.3	1.6	----	----	0.3	0.8	----	1.7	0.3
0.50	0.3	0.3	----	----	0.4	0.2	0.3	----	0.3	----	----	----	0.4	----	----	----
0.60	----	----	----	----	----	----	----	----	----	0.3	----	----	----	----	----	0.3
0.80	0.3	----	----	----	----	----	0.3	----	----	0.3	0.3	----	----	----	0.3	----
1.0	----	----	----	----	0.2	----	----	----	0.6	----	----	----	----	----	----	----
Agglomerates Counted	334		301		476		369		319		379		236		296	

[a] some agglomerates in excess of 1.0 µm diameter observed, but they averaged only 0.05 numerical percent of those counted

TABLE 26. CUMULATIVE AGGLOMERATE SIZE DATA FROM TEM MICROGRAPHS

Agglomerate diameter less than (µm)	Average cumulative percent counted by diameter[a]															
	stage 8, ECD 0.42		stage 7, ECD 0.63		stage 6, ECD 1.02		stage 5, ECD 2.0		stage 4, ECD 3.2		stage 3, ECD 4.6		stage 2, ECD 6.8		stage 1 ECD 11.	
	maj.	min.	maj.	min.	maj.	min.	maj.	min.	maj.	min.	maj.	min.	maj.	min.	maj.	min.
Operating schedule: Cold FTP																
0.02	27.3	47.3	32.2	48.3	30.5	46.2	32.3	44.9	12.8	19.4	30.5	33.3	23.5	33.9	32.5	45.5
0.05	63.8	80.1	65.0	84.4	64.2	80.8	60.2	80.0	30.6	57.2	42.6	54.0	49.0	66.7	63.3	78.3
0.10	84.9	92.1	89.7	94.9	86.8	93.7	84.7	93.0	63.3	87.8	62.7	82.2	76.5	91.0	85.3	94.7
0.15	89.8	96.3	93.4	98.5	91.5	97.2	90.0	98.0	83.7	94.9	77.1	90.8	89.4	96.9	93.1	97.7
0.20	95.4	98.5	97.6	99.6	95.3	98.4	93.5	98.5	87.8	97.5	87.4	93.7	93.8	99.4	94.6	99.2
0.30	98.8	100.	99.1	100.	98.1	100.	96.7	99.5	96.9	99.5	94.3	98.3	99.7	100.	98.9	99.7
0.40	99.5		99.8		99.7		99.2	100.	99.5	100.	98.3	98.9	99.7		99.4	100.
0.50	100.		100.		100.		99.2		99.5		98.9	100.	100.		99.7	
0.60							99.5		100.		98.9				100.	
0.80							100.				100.					
1.0																
Agglomerates Counted	408		466		318		399		196		174		457		396	
Operating schedule: 85 km/h steady-state																
0.02	18.6	28.4	27.9	43.5	18.7	36.6	20.3	39.6	12.2	28.3	20.6	32.5	19.1	40.3	13.9	31.4
0.05	38.9	62.9	60.5	81.0	53.2	76.5	59.1	78.3	39.8	69.1	47.5	76.0	61.4	79.6	42.6	68.6
0.10	70.7	91.3	86.7	95.3	82.1	93.1	84.3	94.0	74.6	88.5	79.9	94.7	83.5	94.1	73.6	87.5
0.15	87.1	95.2	95.0	98.3	89.3	98.1	91.6	97.3	85.0	95.7	91.6	98.7	93.2	96.2	85.1	95.6
0.20	92.2	97.0	97.7	99.3	95.6	99.4	95.4	98.9	91.5	98.5	96.6	99.5	94.9	98.7	91.2	98.3
0.30	97.0	99.4	99.3	100.	98.9	99.6	98.4	99.7	97.5	99.4	99.7	99.7	98.7	100.	98.0	99.3
0.40	99.4	99.7	100.		99.4	99.8	99.5	100.	99.1	99.4	99.7	100.	99.6		99.7	99.7
0.50	99.7	100.			99.8	100.	99.7		99.4	99.4	99.7		100.		99.7	99.7
0.60	99.7				99.8		99.7		99.4	99.7	99.7				99.7	100.
0.80	100.				99.8		100.		99.4	100.	100.				100.	
1.0					100.				100.							
Agglomerates Counted	334		301		476		369		319		379		236		296	

[a] some agglomerates in excess of 1.0 µm diameter observed, but they averaged only 0.05 numerical percent of those counted

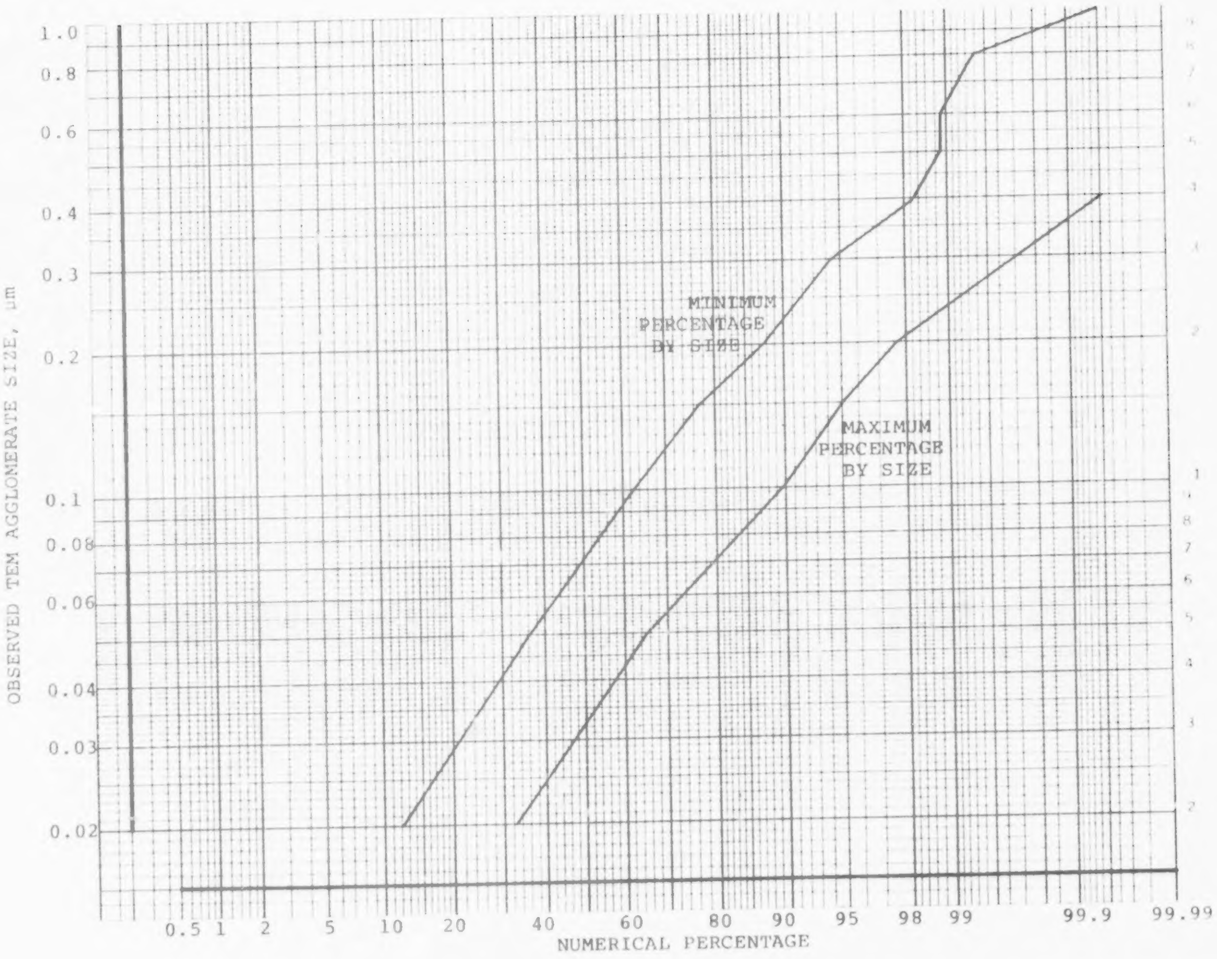

Figure 41. Range of cumulative numerical percentages of agglomerates observed, all collection locations and both test runs

index" for each agglomerate size category based on the square relationship. The last column of Table 27 gives the estimated average cumulative percent by mass based on the square relationship, and both sets of data are also given graphically in Figure 42. This graph indicates that the median agglomerate by mass is about 4.5 times larger than the numerical median agglomerate. It is still probable that two essentially different sets of agglomerates were analyzed by the impactor (larger agglomerates in the central areas of the impaction zones, constituting most of the mass) and by the TEM (smaller agglomerates on the periphery of impaction zones).

TABLE 27. AVERAGE CUMULATIVE AGGLOMERATE DISTRIBUTIONS FROM TEM MICROGRAPHS BASED ON NUMERICAL AND MASS CRITERIA

Minor agglomerate diameter less than (μm)	Cumulative percent, numerical	"Mass index" (arbitrary)	Cumulative percent by mass
0.02	23.8	0.0004	0.6
0.05	54.0	0.0025	5.6
0.10	80.7	0.01	23.2
0.15	89.7	0.0225	36.6
0.20	94.3	0.04	48.7
0.30	98.3	0.09	72.6
0.40	99.5	0.16	84.9
0.50	99.7	0.25	88.1
0.60	99.8	0.36	90.1
0.80	99.9	0.64	96.4
1.0	100.	1.0	100.
Agglomerates counted	5424	----	----

In order to get better TEM results, it would probably be necessary to examine impaction zones on which sampling had occurred for only a few seconds, giving a wider distribution of sizes which could be examined.

D. Analysis of Particulate Composition

This subsection includes data on major elements, sulfate, trace elements, and phenols. Phenol samples were collected in impingers, and all the others were collected on 47 mm filters.

1. Major elements (carbon, hydrogen, nitrogen, and sulfur) in particulate matter

Data on carbon, hydrogen, and nitrogen content of particulate matter were obtained by combustion analysis; and sulfur data were determined by X-ray fluorescence. This information is presented in Tables 28 (Mercedes 240D) and 29 (VW Rabbit Diesel) in terms of weight percent of particulate. Sulfur data are also presented in Appendix G in mg/km, pages G-10 (Mercedes) and G-13 (VW); and in mg/h, pages G-16 (Mercedes) and G-19 (VW).

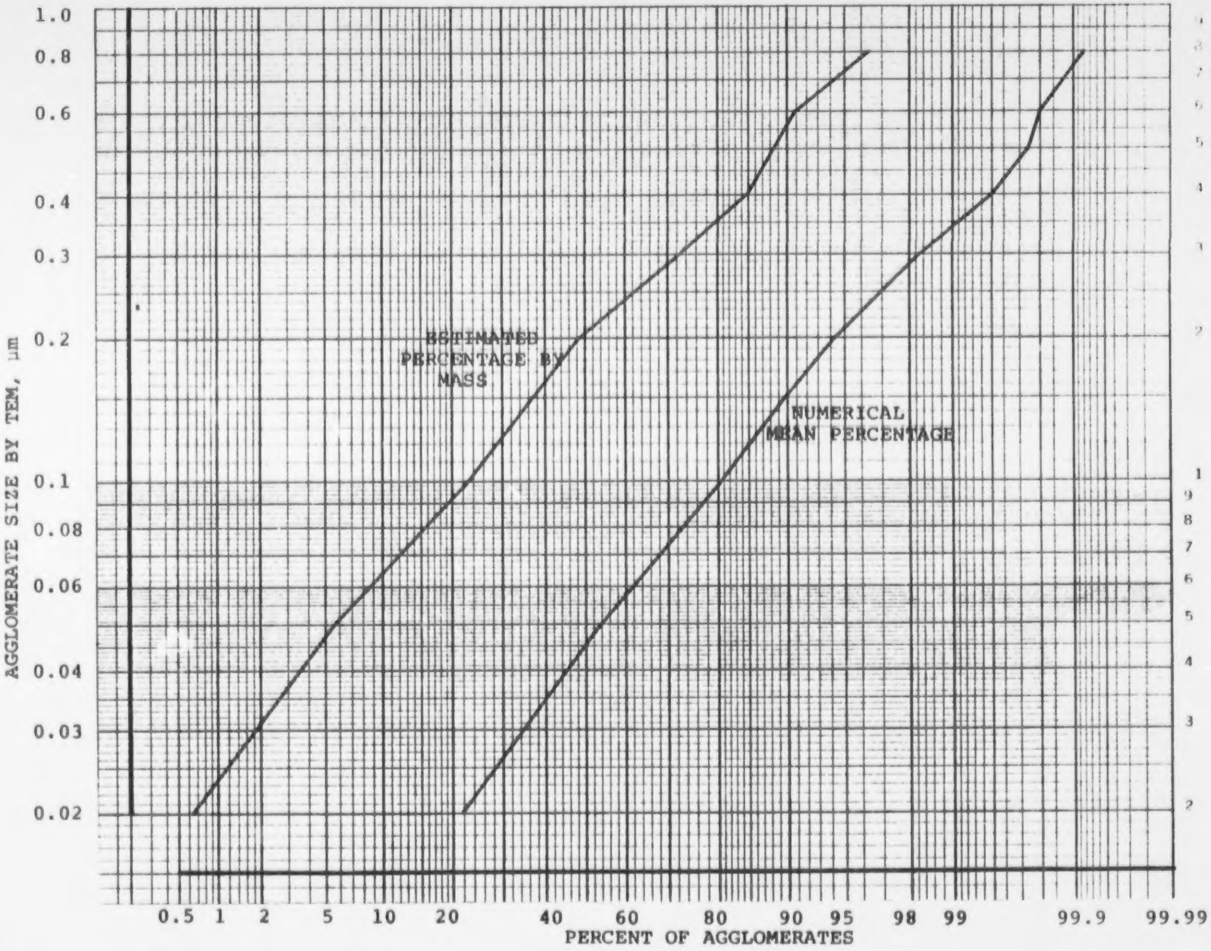

Figure 42. Cumulative mean percentages of agglomerates by number and by mass (estimated), all collection locations and both test runs

TABLE 28. CARBON, HYDROGEN, NITROGEN, AND SULFUR IN EXHAUST PARTICULATE MATTER FROM A MERCEDES 240D OPERATED ON FIVE FUELS

Fuel	Element	Weight Percent of Particulate by Cycle or Mode							
		Cold FTP	Hot FTP	CFDS	FET	NYCC	Idle	50 kph	85 kph
EM-238-F	Carbon	77.1	73.0	72.4	72.9	76.2	62.9	77.9	73.8
	Hydrogen	2.9	2.8	2.6	2.3	2.6	2.5	2.7	3.0
	Nitrogen	0.4	0.3	0.4	0.3	0.5	0.4	0.2	0.4
	Sulfur	1.16	0.99	1.57	1.42	0.53	1.04	0.80	1.89
EM-239-F	Carbon	73.4	74.3	73.5	73.6	84.5	81.4	87.5	75.8
	Hydrogen	3.6	3.9	3.2	2.9	4.8	4.5	3.2	2.9
	Nitrogen	1.0	0.9	2.8	3.2	1.2	2.2	1.9	0.8
	Sulfur	0.91	0.87	1.15	0.99	0.46	0.47	0.54	1.45
EM-240-F	Carbon	79.6	74.0	73.8	90.0	80.2	78.2	88.8	75.6
	Hydrogen	2.8	2.6	2.3	3.0	2.7	4.2	1.1	2.5
	Nitrogen	0.4	0.6	0.9	2.1	2.5	0.4	0.8	0.8
	Sulfur	0.35	0.31	0.50	0.56	0.19	0.31	0.17	0.29
EM-241-F	Carbon	75.3	76.9	74.7	72.5	76.3	66.3	86.2	75.5
	Hydrogen	2.9	3.4	2.8	2.2	2.0	2.7	5.1	3.4
	Nitrogen	0.4	0.4	0.5	0.3	0.4	0.6	0.5	0.4
	Sulfur	0.98	1.03	1.71	1.20	0.68	0.78	0.93	1.43
EM-242-F	Carbon	76.2	72.3	71.8	70.8	75.3	63.6	60.0	77.1
	Hydrogen	2.7	2.6	2.5	2.8	2.6	2.5	3.3	2.6
	Nitrogen	0.4	0.4	0.4	0.5	0.7	0.7	0.7	0.4
	Sulfur	1.37	1.19	2.41	1.88	0.78	1.03	0.92	2.10

TABLE 29. CARBON, HYDROGEN, NITROGEN, AND SULFUR IN EXHAUST PARTICULATE MATTER FROM A VW RABBIT DIESEL OPERATED ON FIVE FUELS

		Weight Percent of Particulate by Cycle or Mode							
Fuel	Element	Cold FTP	Hot FTP	CFDS	FET	NYCC	Idle	50 kph	85 kph
EM-238-F	Carbon	68.8	71.6	74.6	70.2	46.8	32.6	60.4	75.5
	Hydrogen	3.8	4.1	4.4	3.6	3.1	4.0	5.8	3.9
	Nitrogen	0.4	0.4	0.6	0.4	0.2	1.2	0.8	0.5
	Sulfur	0.87	0.98	1.55	1.27	0.55	0.93	0.40	1.44
EM-239-F	Carbon	66.9	71.9	72.4	75.4	59.4	35.3	61.2	83.0
	Hydrogen	3.8	4.6	2.7	4.6	7.6	8.2	8.1	4.5
	Nitrogen	0.8	1.1	1.1	0.9	1.7	1.8	1.3	0.9
	Sulfur	0.76	0.67	1.03	0.84	0.34	0.66	0.35	1.01
EM-240-F	Carbon	66.3	71.6	68.1	66.8	53.8	40.9	60.8	78.0
	Hydrogen	3.2	3.5	4.1	4.2	3.6	2.9	4.9	3.6
	Nitrogen	<0.1	<0.1	<0.3	<0.1	<0.1	<0.1	<0.1	<0.1
	Sulfur	0.48	0.29	0.30	0.26	0.095	0.20	0.060	0.23
EM-241-F	Carbon	70.4	65.9	69.7	71.9	43.7	37.6	56.3	75.0
	Hydrogen	5.3	4.4	3.9	3.6	2.4	4.4	7.7	3.4
	Nitrogen	0.4	0.5	0.5	0.4	0.9	0.7	0.3	0.6
	Sulfur	0.42	0.69	1.04	0.86	0.31	0.60	0.18[a]	0.69
EM-242-F	Carbon	69.3	73.1	69.1	70.9	52.0	26.7	62.7	76.6
	Hydrogen	3.8	4.1	4.1	4.1	4.6	5.1	4.9	4.1
	Nitrogen	0.5	0.7	0.5	0.5	0.8	1.4	1.2	0.4
	Sulfur	1.09	1.15	1.79	0.74	0.32	0.67	0.54[a]	1.40[a]

[a] estimated from incomplete data

The elemental data for both vehicles show a fairly uniform low hydrogen content, indicative of a "dry" or soot-like particulate material rather than an oily material. Carbon content of the particulate matter was highly variable from one test procedure to another, but generally much less variable between fuels. Lower carbon content was generally observed for idle and the NYCC, while higher carbon content was associated with the FET and the 85 kph steady-state. These effects were more pronounced for the VW than for the Mercedes. A substantial amount of the particulate matter is unaccounted for by the sum of C, H, N, and S; about 10.6% to 66.1% for the VW, and about 4.3% to 33.2% for the Mercedes. Major fuel effects seem to be present for sulfur (as expected) and nitrogen. Sulfur percentage was a minimum for both vehicles when EM-240-F fuel was used, and it was at a maximum on EM-242-F in the Mercedes and on EM-238-F in the VW. Nitrogen percentage was at a minimum on EM-240-F in the VW and on EM-238-F in the Mercedes, and it was at a maximum on EM-239-F fuel in both vehicles.

2. Sulfate in particulate matter

Sulfate data were obtained by the BCA method, and this information is given in Table 30 in weight percent of particulate matter. Sulfate data are also presented in Appendix G in mg/km, pages G-10 (Mercedes) and G-13 (VW); and in mg/h, pages G-15 (Mercedes) and G-19 (VW). Trends in the sulfate data were very similar to those discussed earlier for sulfur, except that sulfate was at a maximum on fuel EM-238-F in both vehicles. In general, the sulfate radical made up from a fraction of a percent to some five percent of particulate mass for the Mercedes, and from under one percent to about four percent of particulate mass for the VW.

If sulfur recovery were identical for all tests by both the X-ray (sulfur) method and the BCA (sulfate) method, weight percentages of particulate matter as sulfate would be 3.00 times corresponding weight percentages of particulate matter as sulfate. This relationship is based on the ratio of the molecular weight of the sulfate radical, $SO_4^=$ (96.0616), to the atomic weight of sulfur, S (32.063). One way of comparing recoveries between the two methods is illustrated by the data in Table 31, which show BCA recovery values on the order of 0.7 to 3.5 percent for the Mercedes and 0.4 to 6.2 percent for the VW. Corresponding ranges for X-ray recovery are 0.9 to 3.4 percent for the Mercedes and 0.3 to 5.2 percent for the VW. Over all fuels and conditions, X-ray recoveries for the Mercedes averaged about 1.9 percent, as compared to 1.55 percent for the VW. Recoveries for the BCA averaged about 1.65 percent for the Mercedes and 1.95 percent for the VW. It is assumed that all the remaining fuel sulfur is emitted in the form of gases, notably SO_2.

3. Trace elements in particulate matter

Data on trace elements are given in complete form in Appendix G, pages G-10 and G-11 (Mercedes), and pages G-13 and G-14 (VW). These data are repeated for convenience with the time-based data, pages G-16, -17, -19, and -20. As a whole, these elements made up from about 0.04% to 27% of

TABLE 30. SUMMARY OF SULFATE DATA ON TWO DIESEL VEHICLES

Vehicle	Fuel	$SO_4^=$ in weight % of particulate matter by operating schedule							
		Cold FTP	Hot FTP	CFDS	FET	NYCC	Idle	50 kph	85 kph
Mercedes 240D	EM-238-F	2.60	2.41	3.83	6.13	1.91	2.61	2.27	4.90
	EM-239-F	2.60	2.22	4.25	4.32	1.20	1.36	1.41	4.73
	EM-240-F	1.12	0.72	1.45	1.71	0.47	0.47	0.45	1.10
	EM-241-F	2.35	2.60	4.67	4.65	0.92	1.55	1.87	3.51
	EM-242-F	2.47	3.39	5.42	4.09	1.51	2.10	1.91	4.31
VW Rabbit	EM-238-F	3.13	2.50	4.47	4.05	1.65	2.28	1.56	3.89
	EM-239-F	2.48	2.27	3.66	3.08	1.12	3.30	1.32	3.38
	EM-240-F	1.72	0.92	1.54	0.72	1.42	1.62	0.68	1.36
	EM-241-F	1.95	2.21	3.60	2.87	1.69	3.87	0.56[a]	2.59
	EM-242-F	2.35	1.78	4.29	4.29	1.22	2.57	2.31	2.80

[a] estimated from incomplete data

TABLE 31. SULFUR RECOVERY IN PARTICULATE MATTER BY X-RAY AND BCA

Vehicle	Fuel	Analysis Method	% sulfur recovery by operating schedule and method							
			Cold FTP	Hot FTP	CFDS	FET	NYCC	Idle	50 kph	85 kph
Mercedes 240D	EM-238-F	X-ray	1.5	1.4	2.0	1.6	0.9	1.7	0.9	1.9
		BCA	1.1	1.1	1.6	2.3	1.1	1.4	0.8	1.7
	EM-239-F	X-ray	1.7	1.7	1.8	1.5	0.9	1.3	0.8	1.9
		BCA	1.6	1.5	2.3	2.2	0.8	1.3	0.7	2.0
	EM-240-F	X-ray	3.1	2.7	3.4	3.4	1.2	2.1	1.3	1.8
		BCA	3.3	2.1	3.3	3.5	1.0	1.1	1.2	2.3
	EM-241-F	X-ray	1.8	1.9	2.5	2.0	1.6	2.1	1.3	2.1
		BCA	1.5	1.6	2.3	2.5	0.7	1.4	0.8	1.8
	EM-242-F	X-ray	1.9	1.8	3.3	2.4	1.6	2.3	1.2	3.2
		BCA	1.2	1.7	2.5	1.8	1.0	1.6	0.8	2.2
VW Rabbit Diesel	EM-238-F	X-ray	1.3	1.2	2.3	1.7	0.8	1.4	0.4	1.8
		BCA	1.5	1.1	2.2	1.8	0.8	1.1	0.5	1.6
	EM-239-F	X-ray	1.7	1.3	2.1	1.4	0.8	1.7	0.3	1.8
		BCA	1.8	1.5	2.5	1.7	0.9	2.9	0.4	2.0
	EM-240-F	X-ray	5.2	2.5	2.9	2.5	1.0	1.0	0.3	1.7
		BCA	6.2	2.6	4.9	2.3	5.1	2.7	1.0	3.2
	EM-241-F	X-ray	1.7	1.3	2.0	1.5	0.7	1.4	0.4[a]	1.3
		BCA	2.5	1.3	2.4	1.6	1.2	3.1	0.4[a]	1.6
	EM-242-F	X-ray	1.8	1.6	2.5	1.3	0.7	1.5	0.4[a]	2.3[a]
		BCA	1.3	0.8	2.0	2.5	0.9	1.9	0.5	1.6

[a] estimated from incomplete data

particulate mass for the VW, and some 0.025% to almost 5% for the Mercedes. Sums of trace element percentages appear as variable No. 36 in Appendix G. Trace elements found most commonly in particulate matter from the Mercedes were calcium, zinc, lead, manganese, and phosphorus (all in about 3/4 of the samples). The most common trace elements in particulate matter from the VW were calcium, iron, lead, phosphorus, manganese, and zinc (again in about 3/4 of the samples). Major differences between vehicles were the more frequent occurrences of iron, aluminum, nickel, and magnesium in samples from the VW Rabbit. Possible sources of aluminum, iron, nickel, and manganese include wear products from the engines and corrosion products from the exhaust systems. Lead may be due to low-level contamination of fuel supplies or engine wear products, and calcium, zinc, and phosphorus are possible derived from lubricating oil.

4. Phenols in particulate matter

Gaseous phenols have already been discussed in Section VI, and the results given here reflect the removal of the gaseous ("filtered") phenol values from the total ("unfiltered") measurements. Phenols in particulate matter are summarized in Table 32 in milligrams per hour. This information is also given in the same units in Appendix G, pages G-11 and G-12 (Mercedes), and G-14 and G-15 (VW), as part of the complete data set for statistical analysis. Particulate phenols are given in mg/h on pages G-17 and G-18 (Mercedes), and G-20 and G-21 (VW).

Data in Table 32 indicate low overall amounts of phenols in particulate, on the order of a few milligrams per hour or less. The Mercedes generally emitted more phenol compounds at 85 km/h than at the other conditions, and the Volkswagen's trend was similar but more mixed. Fuel EM-238-F "2D emissions" was associated with higher phenol levels for the Mercedes, while EM-241-F "minimum quality" No. 2 seemed to be related to higher levels from the VW.

To compare particulate phenols with gaseous phenol results, Table 33 has been constructed in the same format and units as Table 13 (found in Section VI). Distribution of particulate phenol compounds is quite different from gaseous phenols for both vehicles at idle and 50 km/h, but more similar at 85 km/h. Where comparable (nonzero) data exist, gaseous phenols were uniformly more abundant for both vehicles.

E. Amount and Composition of Organic Solubles in Particulate Matter

Organic solubles in particulate matter were determined by weighing the amount of solute removed from hi-vol glass fiber filters by Soxhlet extraction in cyclohexane. A summary of these results is given in Table 34, indicating a somewhat greater percentage organic solubles overall for the VW Rabbit. Fuel EM-240-F (No. 1) seemed to generate a greater fraction of organic solubles than the other fuels in the Mercedes 240D, but this percentage may have been offset by the lower overall particulate rates emitted while using this fuel. The remaining fuel and operating schedule effects seemd to be mixed for both vehicles. Overall range for the Mercedes

TABLE 32. SUMMARY OF PHENOL COMPOUNDS IN PARTICULATE MATTER, TIME BASIS

Vehicle	Fuel	Operating Condition	Particulate phenols in mg/hr[a]			
			o-cresol	p-cresol	2,4-xylenol + 2,5-xylenol	2,3-xylenol + 3,5-xylenol
Mercedes 240D	EM-238-F	Idle	0	0	0	0
		50 km/h	1.45	0.75	0	0
		85 km/h	0.60	0.51	0	0
	EM-239-F	Idle	1.00	0	0	0
		50 km/h	0	0	0	0
		85 km/h	0.94	1.02	0	0
	EM-240-F	Idle	0	0	0	0
		50 km/h	0	0	0	0
		85 km/h	1.78	0.60	0	0
	EM-241-F	Idle	0	0	0	0
		50 km/h	0	0	0	0
		85 km/h	0	0	0	0
	EM-242-F	Idle	0	0	0	0
		50 km/h	0	0	0	0
		85 km/h	0.08	0.34	0	0
VW Rabbit Diesel	EM-238-F	Idle	0	0.19	0	0
		50 km/h	0	0	0	0
		85 km/h	1.19	0.76	0	0
	EM-239-F	Idle	0	0.20	0	0
		50 km/h	0	0.25	0	0
		85 km/h	0	0	0	0
	EM-240-F	Idle	0	0	0	0
		50 km/h	0.23	0.50	0	0
		85 km/h	0.26	1.02	0	0
	EM-241-F	Idle	0	0	0.07	0
		50 km/h	0	0	0.12	0
		85 km/h	1.10	2.55	0	2.72
	EM-242-F	Idle	0	0	0	0
		50 km/h	0	0.30	0	0
		85 km/h	0.85	0.68	0	0

[a] other compounds analyzed for (phenol; 2,3,5-trimethyl phenol; 2,6-xylenol; 3,4-xylenol) were not found

TABLE 33. SUMMARY OF PHENOL COMPOUNDS IN PARTICULATE MATTER, DISTANCE BASIS

Vehicle	Operating Schedule	Compound(s)[b]	Particulate phenols in mg/km[a]				
			EM-238-F	EM-239-F	EM-240-F	EM-241-F	EM-242-F
Mercedes 240D	Idle[a]	o-cresol+[c]	0	1.0	0	0	0
		p-cresol	0	0	0	0	0
		2,4- & 2,5-xylenol	0	0	0	0	0
		2,3- & 3,5-xylenol	0	0	0	0	0
	50 km/h	o-cresol+[c]	0.029	0	0	0	0
		p-cresol	0.015	0	0	0	0
		2,4- & 2,5-xylenol	0	0	0	0	0
		2,3- & 3,5-xylenol	0	0	0	0	0
	85 km/h	o-cresol+[c]	0.007	0.011	0.021	0	0.001
		p-cresol	0.006	0.012	0.007	0	0.004
		2,4- & 2,5-xylenol	0	0	0	0	0
		2,3- & 3,5-xylenol	0	0	0	0	0
VW Rabbit Diesel	Idle[a]	o-cresol+[c]	0	0	0	0	0
		p-cresol	0.19	0.20	0	0	0
		2,4- & 2,5-xylenol	0	0	0	0.07	0
		2,3- & 3,5-xylenol	0	0	0	0	0
	50 km/h	o-cresol+[c]	0	0	0.0046	0	0
		p-cresol	0	0.005	0.010	0	0.006
		2,4- & 2,5-xylenol	0	0	0	0.0020	0
		2,3- & 3,5-xylenol	0	0	0	0	0
	85 km/h	o-cresol+[c]	0.014	0	0.003	0.013	0.010
		p-cresol	0.009	0	0.012	0.03	0.008
		2,4- & 2,5-xylenol	0	0	0	0	0
		2,3- & 3,5-xylenol	0	0	0	0.032	0

[a] mg/h instead of mg/km

[b] other compounds analyzed for (phenol; 2,3,5-trimethyl phenol; 2,6-xylenol; 3,4-xylenol) were not found

[c] o-cresol + salicylaldehyde

TABLE 34. ORGANIC SOLUBLE CONTENT OF PARTICULATE MATTER

Vehicle	Fuel	Weight percent organic solubles in particulate matter by operating schedule[a]								
		Cold FTP	Hot FTP	CFDS	FET	NYCC	Idle	50 km/h	85 km/h	Mean percentage
Mercedes 240D	EM-238-F	10.7	11.5	7.7	6.4	11.4	9.3	10.2	7.7	9.4
	EM-239-F	9.7	9.8	7.9	7.6	7.9	6.0	9.0	8.6	8.3
	EM-240-F	12.2	11.9	10.4	11.7	25.7	20.1	12.7	9.8	14.3
	EM-241-F	8.3	7.0	5.5	4.7	3.1	4.1	4.7	6.0	5.4
	EM-242-F	9.5	8.5	7.0	2.3	3.9	6.5	7.3	4.9	6.2
Mean percentage		10.1	9.7	7.7	6.5	10.4	9.2	8.8	7.4	8.7
VW Rabbit Diesel	EM-238-F	12.2	9.8	14.6	9.1	14.4	10.0	14.9	14.0	12.4
	EM-239-F	11.6	14.4	13.2	14.3	27.5	18.4	22.7	12.7	16.8
	EM-240-F	13.2	16.4	15.2	15.3	18.7	19.6	15.7	13.4	15.9
	EM-241-F	11.8	18.4	15.4	15.4	18.0	16.3	15.4	21.6	16.5
	EM-242-F	13.5	13.7	14.3	12.9	11.6	11.4	16.3	7.4	12.6
Mean percentage		12.5	14.5	14.5	13.4	18.0	15.1	17.0	13.8	14.8

[a] average used where possible

was from 2.3 percent to 25.7 percent, and the VW's range was 7.4 to 27.5 percent. These data are also found in Appendix G on pages G-10 and G-16 (Mercedes), and on pages G-13 and G-19 (VW).

1. Major elements in organic solubles

Since in most cases the actual amounts of organic solubles isolated from individual half-filters were on the order of a few milligrams, a number of samples from each vehicle-fuel combination were combined to yield more accurate elemental analysis. The composite samples analyzed consisted of about one-half of combined solubles from two cold FTP half-filters, two hot FTP half-filters, two CFDS half-filters, and one half-filter from each of the remaining cycles and modes. The elemental data, determined by combustion analysis, are shown in Table 35.

TABLE 35. MAJOR ELEMENTS IN ORGANIC SOLUBLES FROM PARTICULATE MATTER

Vehicle	Fuel	Weight percent element(s) in organic solubles					
		carbon	hydrogen	nitrogen	sulfur	oxygen	Σ CHNSO
Mercedes 240D	EM-238-F	82.8	12.4	0.10	0.40	4.2	99.9
	EM-239-F	83.5	12.2	0.08	0.36	3.8	100.0
	EM-240-F	83.2	12.4	0.10	0.39	3.7	99.8
	EM-241-F	83.9	12.2	0.08	0.36	3.4	100.0
	EM-242-F	83.7	12.4	0.13	0.41	3.3	99.9
Mean Values		83.4	12.3	0.10	0.38	3.7	99.9
VW Rabbit Diesel	EM-238-F	83.9	12.7	0.12	0.37	2.9	100.0
	EM-239-F	84.2	12.1	0.08	0.41	3.2	100.0
	EM-240-F	83.7	12.8	0.21	0.35	2.9	99.9
	EM-241-F	84.2	12.4	0.16	0.43	2.7	99.9
	EM-242-F	83.8	12.6	0.11	0.38	3.0	99.9
Mean Values		84.0	12.5	0.14	0.39	2.9	99.9

All of the elemental data are strongly indicative of hydrocarbon-like materials (numeric H/C ratio about 1.75), which is to be expected given the solvent and process used for extraction. Nitrogen and sulfur were both quite low, but oxygen was somewhat more abundant and seemingly vehicle-related. Instances for which the individual CHNSO values do not sum exactly to the summation in the far right column are due to rounding differences.

2. Benzo-α-pyrene (BaP) in organic solubles

BaP in organic solubles was determined by EPA's Research Triangle Park laboratories as part of its in-house measurements program. The resulting data, incorporating averages where possible, are summarized in Table 36. This table indicates the presence of strong fuel effects (EM-241-F "minimum quality" No. 2 higher, EM-242-F "premium" No. 2 lower) and operating cycle effects (FTP's higher, 85 kph steady-state lower). Vehicle effects seem to be mixed, with the Volkswagen producing higher BaP during FTP's (especially cold starts), FET's and 85 kph steady-states; and with the Mercedes generally producing higher BaP at idle and during the NYCC. These data are repeated in Appendix G, pages G-10 (Mercedes) and G-13 (VW). They are also listed on a time basis on pages G-16 (Mercedes) and G-19 (VW).

TABLE 36. SUMMARY OF RESULTS FOR BaP IN PARTICULATE MATTER

		Micrograms per Kilometer by Operating Cycle or Mode							
							Steady-State Modes		
Vehicle	Fuel	Cold FTP	Hot FTP	CFDS	FET	NYCC	Idle[a]	50 kph	85 kph
Mercedes 240D	EM-238-F	0.38	0.39	0.13	0.076	1.9	12.	0.14	0.079
	EM-239-F	0.54	0.40	0.19	0.067	2.7	19.	0.12	0.033
	EM-240-F	0.38	0.28	0.17	0.16	0.75	9.2	0.048	0.14
	EM-241-F	0.74	0.53	0.16	0.086	4.0	55.	0.15	0.035
	EM-242-F	0.23	0.23	0.13	0.15	0.75	4.1	0.38	0.028
VW Rabbit diesel	EM-238-F	1.9	0.55	0.36	0.39	1.7	4.5	0.34	0.25
	EM-239-F	2.3	0.60	0.39	0.25	1.6	5.3	0.33	0.22
	EM-240-F	2.0	0.56	1.2	0.87	0.35	---[b]	0.019	0.74
	EM-241-F	7.0	1.1	0.73	0.41	1.5	4.8	0.096	0.32
	EM-242-F	1.8	0.48	0.30	0.40	1.4	3.5	0.18	0.10

[a] micrograms per hour instead of micrograms per kilometer

[b] below minimum detectable limit; in this case, under 0.35 μg/h

3. Gas Chromatograph "boiling range" analysis of organic solubles

Composite samples of organic solubles (described in Section VII. E.1.) representing each vehicle-fuel combination were subjected to quantitative high-temperature gas chromatograph analysis. A number of blanks and standards, and a real crude oil, were also run to provide calibration and background information. Chromatograms given in Appendix G are as follows:

page no(s).	figure no(s).	description
G-43	G-9	cyclohexane blank
G-44	G-10	cyclohexane + C_9-C_{11} internal standard
G-45	G-11	cyclohexane + C_9-C_{11} internal standard + C_{40} spike
G-46	G-12	residue standard
G-47	G-13	"Altamont" crude oil (example)
G-48 thru G-55	G-14 thru G-21	samples of organic solubles from the Mercedes 240D, with C_9-C_{11} internal standard + cyclohexane
G-56 thru G-62	G-22 thru G-28	samples of organic solubles from the VW Rabbit Diesel, with C_9-C_{11} internal standard + cyclohexane

The composition of the standards are given on the same pages as the corresponding chromatograms.

The cyclohexane blank shown on page G-43 (Figure G-9) is typical of those run at least once per operating day on the gas chromatograph. It shows no column contamination and a very flat baseline. The internal standard shown on page G-44 (Figure G-10) is the same group of compoinds mixed with each sample of solubles to provide quantitative recovery and boiling range information. This standard ends sharply prior to 12 minutes after injection, and the remainder of the chromatogram stays on the baseline. Figure G-11 (page G-45) shows the C_9-C_{11} internal standard and a C_{40} spike at a higher attenuation, and with half the normal sample amount injected.

The "residue standard" shown on page G-46 (Figure G-12) incorporates the 5-compound C_9-C_{11} standard, plus a number of higher-boiling constituents. Its purpose was to show separation of certain pure compounds and to check on response factors. A crude oil termed "Altamont" (after its source) is shown on page G-47 (Figure G-13), with strong paraffin peaks and a small "envelope" of other compounds ranging up to 10 scale units or more above baseline. It is assumed that these non-paraffins include cyclics, olefins, and substituted compounds.

The chromatograms for samples of organic solubles from the Mercedes 240D, given as pages G-48 through G-55, exhibit more similarity than differences when taken as a group. Many of the same peaks are visible in each figure, and the ratio of paraffin peak area to "envelope" area appears quite constant. Total sample area on the chromatograms varies quite a bit, mostly due to differences in sample concentration (in cyclohexane) and fraction of internal standard present. Sample chromatograms are presented on a larger scale than the five "standard" chromatograms which constitute pages G-43 through G-47. This change was made to exhance detail, while eliminating the superfluous cyclohexane and internal standard peaks occurring between 4 and 14 minutes after injection. A number of the Mercedes chromatograms have a faily large peak at about 20.7 minutes, indicative of a compound near n-C_{24}.

Chromatograms for samples of organic solubles from the VW Rabbit Diesel are given as pages G-56 through G-62. These samples exhibited more variability than those from the Mercedes, particularly in strength of paraffin peaks as compared to size of "envelope". Fuel EM-241-F "mimimum quality" No. 2 showed larger peaks than the other fuels using this method of comparison, and EM-240-F No. 1 fuel showed smaller peaks. The relatively large peak at about n-C_{24} (mentioned above for the Mercedes) was prominent in samples of solubles from operation on fuels EM-240-F and EM-242-F ("premium" No. 2).

The chromatographic data on solubles are presented in numerical form in Table 37 for the Mercedes, and in Table 38 for the Volkswagen. The principle of the boiling range is self-explanatory, and the percentage recovery was determined from peak data on the internal standard and known amounts of standard and sample mixed together. Factors contributing to inaccuracy in recoveries include errors in weights of sample and standard (these mixtures contained only a few milligrams), inconsistencies in integration of peak data, and so forth. The only two recovery values which are obviously in error are those for samples generated using fuel EM-240-F in the Volkswagen (they exceed 100%), but some degree of error is likely present in all the values.

Data on abundance of n-paraffins (identifiable peaks) were normalized to a total of 1.00 for each sample to enhance comparison of distribution within the samples. Most of the identifiable paraffins fell between C_{15} and C_{24}, with an occasional large peak indicated for C_{28} due to the computer's integrating it from valley to baseline and thereby assigning it a large peak area. The large C_{28} values are not considered to be realistic, but they can not legitimately be removed from the data. No fuel influences seem to be present in data on either vehicle.

To further summarize the boiling range data, Table 39 shows distillation temperature means, coefficients of variation, and extremes for both vehicles in addition to recovery data. Although boiling ranges for all the samples were quite similar throughout most of the range, samples from the VW had slightly lower boiling temperatures. The VW samples also showed somewhat higher recoveries overall, even after removal of the influence of results showing recoveries over 100%. As a final look at the chromatograph data, their range (for both vehicles) has been plotted along with fuel and oil boiling ranges in Figure 43. This graph shows that the oils had a marginally higher boiling range than solubles, which were in turn considerably higher-boiling than fuels.

TABLE 37. CHROMATOGRAPH ANALYSIS OF ORGANIC SOLUBLES IN PARTICULATE MATTER FOR MERCEDES 240D

Distillation Point	Boiling temperature at distillation point by fuel, °C							
	EM-238-F	EM-239-F	EM-239-F[a]	EM-240-F	EM-241-F	EM-241-F[a]	EM-242-F	EM-242-F[a]
IBP	318	305	303	327	307	297	313	290
10% point	370	367	364	366	352	353	358	356
20% point	390	386	385	385	374	375	377	378
30% point	406	400	399	396	388	391	391	392
40% point	422	414	413	408	402	405	403	405
50% point	440	428	426	419	416	419	415	418
60% point	483	443	443	432	432	434	427	430
70% point	---	477	482	445	448	450	441	442
80% point	---	598	---	476	514	519	462	471
90% point	---	---	---	585	---	---	517	580
EP	---	---	---	---	---	---	---	---
Recovery, %, @ temperature, °C	62.7 607	80.4 598	79.5 606	91.2 600	84.8 600	83.1 602	95.7 600	91.2 609

Carbon number	Normalized abundance of (fraction of total) n-paraffins at carbon number by fuel							
	EM-238-F	EM-239-F	EM-239-F[a]	EM-240-F	EM-241-F	EM-241-F[a]	EM-242-F	EM-242-F[a]
15	-----	-----	0.003	0.005	0.004	0.010	0.001	0.002
16	-----	0.003	0.001	0.001	0.001	0.002	-----	0.001
17	0.004	0.045	0.021	0.021	0.027	0.044	0.006	0.007
18	0.020	0.057	0.039	0.035	0.120	0.146	0.010	0.018
19	-----	-----	-----	-----	-----	-----	-----	0.035
20	0.045	0.079	0.068	0.036	0.183	0.205	0.019	0.044
21	-----	-----	-----	0.051	0.345	-----	-----	0.063
22	0.105	0.291	0.217	0.030	-----	0.296	0.069	0.036
23	-----	-----	0.243	0.134	-----	-----	0.061	0.071
24	0.146	0.511	0.407	0.664	0.319	0.290	0.088	0.189
25	-----	-----	-----	-----	-----	-----	-----	-----
28[b]	0.680[b]	0.014	0.001	0.021	-----	0.006	0.745[b]	0.534[b]
n-paraffins as % peak data	30.2	18.5	21.1	46.5	10.0	17.6	49.9	63.6

[a] repeat

[b] C_{28} integrated from valley to baseline for those samples in which it appears to be a major constituent - this result not considered realistic

TABLE 38. CHROMATOGRAPH ANALYSIS OF ORGANIC SOLUBLES IN PARTICULATE MATTER FOR THE VE RABBIT DIESEL

Distillation Point	Boiling temperature at distillation point by fuel, °C						
	EM-238-F	EM-239-F	EM-240-F	EM-240-F[a]	EM-241-F	EM-242-F	EM-242-F[a]
IBP	310	301	331	328	313	312	313
10% point,	358	359	364	365	341	349	349
20% point,	376	376	379	378	354	365	365
30% point,	390	390	391	391	369	379	379
40% point,	407	405	402	403	386	393	393
50% point,	424	423	416	415	403	408	408
60% point,	445	443	431	430	427	425	425
70% point,	473	466	445	445	459	442	442
80% point,	515	509	465	463	517	464	464
90% point,	---	---	493	489	---	508	508
EP	---	---	545	536	---	---	---
Recovery, % @ temperature, °C	88.0 600	90.6 600	107.9 600	109.1 600	86.0 600	99.3 600	99.2 600

Carbon number	Normalized abundance of (fraction of total) n-paraffins at carbon number by fuel						
	EM-238-F	EM-239-F	EM-240-F	EM-240-F[a]	EM-241-F	EM-242-F	EM-242-F[a]
15	-----	-----	-----	0.004	0.002	0.006	0.002
16	-----	-----	-----	-----	-----	-----	0.002
17	0.002	0.002	0.004	0.010	0.020	0.023	0.025
18	0.008	0.008	0.006	0.013	0.108	0.165	0.116
19	-----	-----	0.009	0.015	-----	-----	-----
20	0.041	0.048	0.051	0.065	0.137	0.355	0.221
21	0.118	-----	0.099	0.115	-----	-----	-----
22	-----	0.141	0.099	0.118	-----	-----	0.403
23	-----	-----	0.121	0.125	0.223	-----	-----
24	0.105	0.126	0.612	0.535	0.511	0.451	0.231
25	-----	0.126	-----	-----	-----	-----	-----
28[b]	0.727[b]	0.548[b]	-----	-----	-----	-----	-----
n-paraffins as % peak data	37.1	39.0	53.7	66.1	21.9	7.4	11.6

[a] repeat

[b] C_{28} integrated from valley to baseline for those samples in which it appears to be a major constituent - this result not considered realistic

TABLE 39. SUMMARY OF BOILING RANGE AND RECOVERY DATA FOR ORGANIC SOLUBLE FRACTION OF PARTICULATE

Distillation Point	Boiling temperature statistics at distillation point by vehicle, °C							
	Mercedes 240D				VW Rabbit Diesel			
	low	high	mean	s/$\bar{x}$	low	high	mean	s/$\bar{x}$
IBP	290	327	308	0.038	301	328	315	0.033
10% point	352	370	361	0.019	341	365	355	0.025
20% point	374	390	381	0.016	354	379	370	0.025
30% point	388	406	395	0.015	369	391	384	0.022
40% point	402	422	409	0.017	386	407	398	0.020
50% point	415	440	423	0.020	403	424	414	0.019
60% point	427	483	440	0.041	425	445	432	0.019
70% point	441	---	---	-----	442	473	453	0.028
80% point	462	---	---	-----	463	517	485	0.055
90% point	517	---	---	-----	489	---	---	-----
EP	---	---	---	-----	536	---	---	-----
Recovery, %	67.2	95.7	84.1	0.106	86.0	(100)[a] 109.1	(94.7)[a] 97.2	(0.066)[a] 0.096

[a] figures in parentheses assume highest recovery was 100.0%

F. Other Particulate Emissions Data

In addition to particulate emission data in (mass/distance) and (mass/time) already discussed, particulate results were also computed for the most important variables (all except 13-30, 35, and 36) in fuel specific units (mass/kg fuel). These data are given as pages G-63 (Mercedes) and G-64 (VW) of Appendix G, their major intended use being input to impact calculations where category fuel consumption is available.

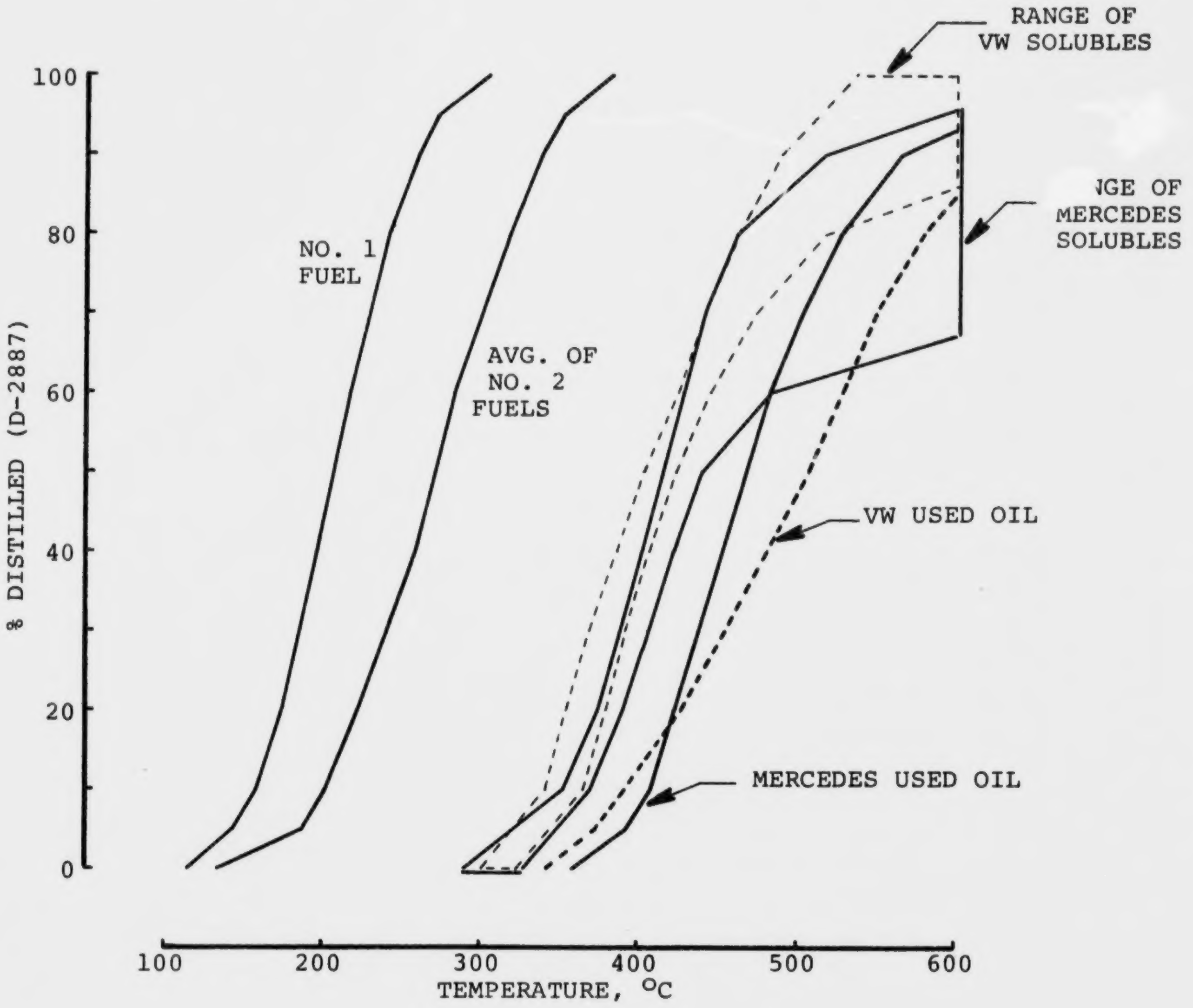

Figure 43. Boiling ranges for fuels, oils, and solubles

VIII. MUTAGENIC ACTIVITY OF ORGANIC SOLUBLES IN PARTICULATE MATTER, RESULTS AND ANALYSIS

As a part of EPA's in-house measurements program at the Health Effects Research Laboratory, Research Triangle Park, portions of some of the samples submitted for organic solubles determination and BaP analysis were subjected to the Ames Bioassay to determine their mutagenic activity(27,28). The data resulting from this sub-investigation, not originally intended to be a part of the subject contract, were submitted to the Project Officer by HERL personnel. Following his review, the data were submitted to SwRI for analysis and inclusion in this report.

The term "Ames Bioassay" is colloquial, and it refers to a bacterial mutagenesis plate incorporation assay with Salmonella typhimurium according to the method of Ames, et al(27). This bioassay determines the ability of chemical compounds or mixtures to cause mutation of DNA in the bacteria, positive results occurring when histidine-dependent strains of bacteria revert (or are mutated) genetically to forms which can synthesize histidine on their own. The observable positive indication of mutation is the growth of bacterial colonies on plates of nutrient media containing minimal histidine, with the number of revertants per amount of substance tested (or "specific activity") being the quantitative result. The observable negative indication is the lack of such growth. A third result occurs when the substance tested is toxic to the bacteria, but this result can not be interpreted in terms of mutagenesis. Results of the Ames Bioassay have been shown to correlate strongly with carcinogenic action on animals for individual chemicals(29-31). No such results are known for complex mixtures of chemical substances.

At the time samples resulting from work on this Contract were run, procedures for handling and storing Diesel particulate samples and extracts were not well developed. Consequently, the results presented here may reflect some sample degradation as compared to newer work with better sample handling (e.g., filter handling only under yellow light and shipped in dry ice, extracts kept dark and cold, etc.), so these results may be conservative. All the results reported here were obtained using (bacterial) strain TA1538, chosen on the basis of prior work on extracts from two heavy-duty Diesel engines(28). Strain TA1538 is reverted mainly by frameshift mutagens. Strain TA100 appeared more sensitive to mutagens in the heavy-duty extracts, because is is reverted by both frameshift mutation and base-pair substitution. The extracts seemed to have a more pronounced toxic effect on TA100, however, and it also showed smaller differences between samples with and without metabolic activation than did TA1538(28). Metabolic activation was performed by mixing the test substances with a preparation made from rat liver homogenate, converting some substances to forms more easily metabolized by the bacteria.

Background data on the samples, as well as specific activity values, are summarized in Table 40. This information represents only 16 independent samples (filter numbers), eight for each vehicle, so it can not in any way be considered conclusive. Of the five filters from which two samples were extracted (all for Mercedes), repeatability was very good (average deviation about 10% without activation, 5% with activation); but the second sample was uniformly lower without activation, while it was higher in 4 of the 5 cases with activation. These seemingly directional effects may be quite random, but their nature will not be known with greater certainty until a great many more samples are analyzed.

A basic statistical analysis has been run on these data, resulting (first) in the computed values given in Table 41. The means show a strong vehicle effect, and a strong fuel effect for EM-241-F "minimum quality" No. 2 fuel, both of which are more dominant in the data for samples which were metabolically activated. Activation appeared to increase mean mutagenic activity values by factors of about 1.8 for the Mercedes, and 2.4 for the VW Rabbit. These factors ranged from about 1.9 for EM-242-F "premium" No. 2 fuel to 2.4 for EM-241-F. Coefficients of variation (standard deviation/mean) were generally higher for activated samples than for corresponding samples without activation.

Table 42 shows the results of an analysis of variance conducted on vehicle and fuel specific activity responses. The "F" statistics and their significance levels indicate high probabilities that mean specific activity responses for the two vehicles and the five fuels are, in fact, different. Table 43 shows the strength of individual linear relationships between specific activity and fuel variables for both vehicles taken together. This table indicates that specific activity (both with and without metabolic activation) is quite strongly related (numerically) to fuel nitrogen (91), cetane index (61), and hydrocarbon type composition (represented by 89, 90, 93, and 95). The individual fuel variables are very highly correlated with one another, also, so it was not considered feasible to run multiple regressions.

The specific activity data were further analyzed by comparing them to other corresponding emissions data. In order to minimize unaccounted-for variability, the data considered in this manner consisted only of those obtained for cold FTP runs. Averages were used where multiple data values existed, as shown in Table 44. The corresponding emissions values chosen for Table 44 included those perhaps most likely to correlate with specific activity, namely; filtered particulate mass (essentially proportional to particulate rate), percent organic solubles in particulate matter, BaP, nitrogen in particulate matter, and gaseous total HC. Of these variables, gaseous HC was the strongest correlator with specific activity of metabolically activated extract (+MA), followed by total particulate and then BaP. Gaseous HC also correlated most strongly with specific activity of non-activated extract (-MA), followed by BaP and then total particulate. Specific activity both with and without metabolic activation appeared to have an inverse relationship with percent organic solubles in particulate matter, much more strongly so for the Mercedes

TABLE 40. AMES BIOASSAY DATA ON SAMPLES FROM TWO DIESEL AUTOMOBILES

Vehicle	Fuel	Operating schedule	Filter number	Total filter particulate, mg	Specific Activity of Extract, adjusted revertants/mg^a	
					with metabolic activation (+MA)	without metabolic activation (-MA)
Mercedes 240D	EM-238-F	cold FTP	8024-1	158.9	49.0	25.9
			8024-2		51.1	22.3
	EM-239-F	cold FTP	8053-1	156.5	70.0	38.0
			8053-2		76.7	35.4
	EM-240-F	cold FTP	8078-1	120.0	53.9	30.1
			8078-2		54.2	27.3
	EM-241-F	cold FTP	8088	173.8	117.1	60.5
		cold FTP	8111	184.4	258.9	133.2
		cold FTP	8114	208.1	84.6	46.4
	EM-242-F	85 kph	8133-1	192.4	64.3	56.9
			8133-2		79.1	55.8
		cold FTP	8142-1	134.2	58.5	34.2
			8142-2		49.9	27.6
VW Rabbit	EM-238-F	cold FTP	8027	123.2	90.1	38.3
	EM-239-F	cold FTP	8060	100.4	61.5	27.6
	EM-240-F	cold FTP	8081	104.0	115.0	52.2
	EM-241-F	cold FTP	8096	143.6	315.2	127.0
		cold FTP	8104	196.8	596.6	242.7
		cold FTP	8116	175.3	482.4	173.2
	EM-242-F	85 kph	8125	165.5	94.7	49.0
		cold FTP	8140	92.8	109.0	52.0

[a] units are: adjusted revertants/mg particulate extracted

TABLE 41. MEAN AND STANDARD DEVIATION OF SPECIFIC ACTIVITY FOR VEHICLES AND FUEL TYPES

	Specific activity, adjusted revertants/mg particulate extracted			
	with metabolic activation(+MA)		without metabolic activation (-MA)	
Vehicle	Mean	Std. Dev.	Mean	Std. Dev.
Mercedes 240D	76.98	43.48	41.64	21.92
VW Rabbit Diesel	168.06	167.13	70.18	62.69
Fuel				
EM-238-F	69.55	26.09	32.10	8.77
EM-239-F	65.75	6.01	32.80	7.35
EM-240-F	84.45	43.20	41.15	15.63
EM-241-F	309.10	220.05	130.40	71.28
EM-242-F	83.75	35.71	43.10	12.59

TABLE 42. ANALYSIS OF VARIANCE TABLES FOR SPECIFIC ACTIVITY VERSUS VEHICLES AND FUEL TYPES

ANOVA TABLE FOR SAMPLES WITH METABOLIC ACTIVATION (+MA)

Source of Variation	degrees of freedom	Sum of Squares	Mean Square	F	Sig of F
Vehicle Type	1	20738.916	20738.916	2.616	.181 (NS)
Fuel Type	4	87586.376	21896.594	2.762	.174 (NS)
Error	4	31706.264	7926.566		
Total	9	140031.556			

ANOVA TABLE FOR SAMPLES WITHOUT METABOLIC ACTIVATION (-MA)

Source of Variation	degrees of freedom	Sum of Squares	Mean Square	F	Sig of F
Vehicle Type	1	2036.329	2036.329	2.277	.206 (NS)
Fuel Type	4	14063.404	3515.851	3.931	.107 (NS)
Error	4	3577.576	894.394		
Total	9	19677.309			

TABLE 43. MEANS, STANDARD DEVIATION, AND PAIRWISE CORRELATIONS BETWEEN SPECIFIC ACTIVITY AND FUEL COMPOSITION VARIABLES

Variable	Variable Number	Mean	Standard Deviation	Pairwise correlation (r) of fuel variable with specific activity	
				with metabolic activation (+MA)	without metabolic activation (-MA)
Density	59	0.8374	0.0194	.4667	.4838
Viscosity	60	2.338	0.4965	.0434	.0380
Cetane Index	61	47.9	3.79	-.6580	-.6867
Flash Point	62	72.6	17.23	-.1672	-.2034
Initial Boiling Point	76	134.6	8.78	.0023	-.0129
5% Point	77	186.2	13.62	.0462	.0349
10% Point	78	200.4	13.49	.2269	.2365
20% Point	79	221.6	20.14	.3250	.3466
30% Point	80	241.4	23.15	.2223	.2310
40% Point	81	258.8	27.92	.1718	.1752
50% Point	82	271.0	29.04	.1618	.1652
60% Point	83	282.4	29.24	.1562	.1598
70% Point	84	300.2	31.46	.1197	.1200
80% Point	85	320.4	36.32	.1078	.1076
90% Point	86	342.2	36.74	.0957	.0944
95% Point	87	356.4	38.11	.0665	.0627
End Point	88	394.6	39.39	-.0214	-.0403
Carbon	89	86.72	0.487	.6320	.6576
Hydrogen	90	13.08	0.518	-.5892	-.6100
Nitrogen	91	0.0096	0.0077	.7869	.8433
Sulfur	92	0.228	0.1078	.0878	.0793
Aromatics	93	22.28	9.340	.5103	.5180
Olefins	94	1.52	1.038	-.1786	-.1947
Paraffins	95	76.2	9.02	-.5079	-.5140
Gum	96	6.0	4.47	.4159	.4193

TABLE 44. COMPARISON OF MUTAGENIC ACTIVITY WITH OTHER EMISSIONS DATA, COLD FTP RUNS ONLY

Vehicle	Emission variable	Value of variable by fuel (averages in parentheses)					Pairwise correlation (r) of emission variable with Specific Activity	
		EM-238-F	EM-239-F	EM-240-F	EM-241-F	EM-242-F	with metabolic activation (+MA)	without metabolic activation (-MA)
Mercedes 240D	specific activity (+MA)[a]	(50.0)	(73.4)	(54.0)	(153.5)	(54.2)	------	------
	specific activity (-MA)[b]	(24.1)	(36.7)	(28.7)	(40.0)	(30.9)	------	------
	particulate mass collected, mg	158.931	156.543	120.031	(188.779)	134.202	+0.817	+0.580
	percent organic solubles	(10.7)	(9.7)	(12.2)	(8.3)	(9.5)	-0.733	-0.737
	BaP, ng/mg particulate mass	0.76	1.87	1.46	(2.04)	1.10	+0.756	+0.931
	N in particulate matter, mg/km	(1.34)	(3.19)	(1.00)	(1.63)	(1.20)	+0.172	+0.546
	gaseous HC, g/km	(0.14)	(0.21)	(0.10)	(0.24)	(0.14)	+0.830	+0.862
VW Rabbit Diesel	specific activity (+MA)[a]	90.1	61.5	115.0	464.7	109.0	------	------
	specific activity (-MA)[b]	38.3	27.6	52.2	181.0	52.0	------	------
	particulate mass collected, mg	123.163	100.441	103.956	(171.908)	92.760	+0.923	+0.907
	percent organic solubles	(12.2)	(11.6)	(13.2)	(11.8)	(13.5)	-0.326	-0.284
	BaP, ng/mg particulate mass	7.02	14.5	10.3	(21.0)	10.5	+0.829	+0.822
	N in particulate matter, mg/km	(1.01)	(2.00)	(0.46)	(2.26)	(1.10)	+0.581	+0.559
	gaseous HC, g/km	(0.23)	(0.28)	(0.24)	(1.12)	(0.26)	+0.987	+0.982

[a] with metabolic activation, in "adjusted revertants per mg particulate matter extracted"

[b] without metabolic activation, in "adjusted revertants per mg particulate matter extracted"

than for the VW. Correlations between particulate nitrogen and specific activity were quite low.

It is difficult to attach physical significance to these few data points, but if the trends observed so far remained consistent for larger numbers of samples, it would suggest that production of mutagens (as determined by the Ames Bioassay) in exhaust particulate matter is related to production of BaP and gaseous HC in some way. These relationships might be the result of coincidental processes or physically similar processes, and a great deal more information would be required in order to decide the nature of the correlation.

IX. STATISTICAL ANALYSIS OF FUEL AND EMISSIONS DATA

The analysis of emissions data given in previous report sections VI. and VII. has several goals. These goals include identification of existing trends and relationships between emissions and the two test vehicles, the five test fuels, and the eight vehicle operating schedules (nine schedules including computed values for the 1975 "3-bag" FTP). Some of the more obvious relationships have already been discussed briefly along with presentation of results.

A. Statistical Methodology

Examining the mass of data given in Appendices F and G, it is easy to conclude erroneously that virtually any type of statistical analysis could be conducted on the results of this program. The data must be examined, however, in light of the number of observations in each well-defined data subgroup. The number of observations (some of which represent averages) in each data subgroup are as follows:

Data Subgroup	Subgroup Composition	Observations per Emission Variable
A - all data	2 veh. x 5 fuel x 8 schedule	80[a]
B - each vehicle	1 veh. x 5 fuel x 8 schedule	40[a]
C - number of points, each vehicle and fuel	1 veh. x 1 fuel x 8 schedule	8[a]
D - each vehicle and schedule	1 veh. x 5 fuel x 1 schedule	5
E - each vehicle, fuel and schedule	1 veh. x 1 fuel x 1 schedule	1

[a] not including derived 3-bag (1975) FTP results

If subgroups having large numbers of observations were used for regressions, a great deal of variability would be present in the data which could not legitimately be explained by the independent variables (i.e., fuel variables or schedule variables). If data subgroup D were used, multiple linear regressions on five observations would be futile even if the five fuels were considered variables in themselves. This problem becomes much worse if it is attempted to regress dependent variables against 38 individual fuel property variables. Use of data subgroup C for regression of emissions against operating schedule properties (8 observations, 4 schedule variables) appears more promising, expecially if regressions could be truncated after inclusion of the most important independent variables.

Regression analysis on data presented in this report, based on the above considerations, was used only on selected, important emission variables. These variables were regressed against schedule variables in subgroup C, and a few of them were regressed against selected fuel variables (based on assumed physical importance) in subgroup D.

A related technique considered for use with the emissions data was biased multiple regression, a method appropriate for situations in which the independent variables (fuel variables in this case) are in fact highly correlated. The foregoing discussion on the available data for each vehicle and operating schedule (5 points) applies as well to biased regressions, however, precluding their use in this project.

Given the difficulty in obtaining meaningful results via regressions as discussed above, it was decided to conduct analysis of variance on means of grouped data, and to examine pairwise correlations between emission variables and fuel variables for the two vehicles individually. The tabular form in which data will be presented is shown in the example below. Data computed and tabulated in this form will be presented only for nine selected emission variables (total particulate mass, percent solubles in particulate matter, particulate sulfur and sulfate, BaP, percent of particulate mass unaccounted for by major elements, and gaseous HC, CO , and NO_x). These tables are presented in subsection IX.E.

Vehicle____________________ Emission variable__________________________

Inverse rank-ordered		Pairwise correlations between ____________ and fuel variables for indicated operating schedules					
operating schedule	mean value of variable[a]	highest	r	2nd highest	r	3rd highest	r

Inverse rank-ordered	
fuel	mean value of variable[a]

[a] brackets surround means not significantly different at the 0.05 level

Referring to the tabular form example given above, significance of differences between means were determined using multiple range tests. This comparison permitted the grouping of similar means according to consistent criteria, providing greater insight into operating schedule effects on emissions. The pairwise correlations listed in order of decreasing absolute value give some indication of important fuel variables for each variable. Although the fuel variable listed first is the one which would be included first in a multiple linear regression model, the others are not likely to be those listed second and third in such a model due to dependence of fuel variables on each other.

Since it was obvious that vehicle operating schedules had pronounced effects of emissions, the operating schedules were analyzed to determine their salient characteristics. It was decided that the statistics shown in Table 7 (section V) were essential to description of the schedules in the following order of importance: average speed, percent idle time, speed coefficient of variation, and number of stops per hour. Regression analysis using average emissions as dependent variables and schedule statistics as independent variables is presented in subsection IX.F.

B. Numbering of Variables

To make computer analysis simpler, all the fuel variables, emission variables, and certain other parameters were assigned numerical variable codes. Table 45 is a list of these codes for reference. A brief summary of code intervals for the major classes of data is as follows:

Code(s)	Parameter or variable class
1	operating schedule parameter (0='75 FTP, ..., 8=85 km/h)
2	vehicle parameter (1=Mercedes, 2=VW Rabbit)
3	fuel parameter (1=EM-238-F, ..., 5=EM-242-F)
4-36	particulate variables
40-55	gaseous emissions variables
59-96	fuel variables
uncoded	operating schedule variables

The assigned variable codes apply as given regardless of the units in which emission values are expressed (e.g., g/km, g/h, or g/kg fuel). Note that particulate phenols are coded as variables 31-34, while gaseous phenols are coded 52-55. The other emissions were measured in one phase or the other, but not (directly) in both.

TABLE 45. CODING OF FUEL, OPERATING SCHEDULE, AND EMISSION VARIABLES, AND OTHER PARAMETERS

Code	Parameter or Variable	Code	Variable	Code	Variable
1	operating schedule	33	(particulate) 2,4-xylenol[b]	70	60% point by D-86
2	vehicle	34	(particulate) 2,3-xylenol[c]	71	70% point by D-86
3	fuel	35	100 - (CHNS) %	72	80% point by D-86
		36	sum variables (13-30)	73	90% point by D-86
4	total particulate mass			74	95% point by D-86
5	particulate concentration	40	HC	75	EP by D-86
6	solubles in particulate matter	41	CO	76	IBP by D-2887
7	C in particulate matter	42	NO_x	77	5% point by D-2887
8	H in particulate matter	43	CO_2	78	10% point by D-2887
9	N in particulate matter	44	fuel	79	20% point by D-2887
10	S in particulate matter	45	formaldehyde	80	30% point by D-2887
11	$SO_4^=$ in particulate matter	46	acetaldehyde	81	40% point by D-2887
12	BaP in solubles	47	acetone[d]	82	50% point by D-2887
13	Cr in particulate matter	48	isobutyraldehyde	83	60% point by D-2887
14	Pb in particulate matter	49	crotonal	84	70% point by D-2887
15	Mn in particulate matter	50	hexanal	85	80% point by D-2887
16	Br in particulate matter	51	benzaldehyde	86	90% point by D-2887
17	P in particulate matter	52	(gaseous) o-cresol[a]	87	95% point by D-2887
18	Si in particulate matter	53	(gaseous) p-cresol	88	EP by D-2887
19	Cd in particulate matter	54	(gaseous) 2,4-xylenol[b]	89	C in fuel
20	Al in particulate matter	55	(gaseous) 2,3-xylenol[c]	90	H in fuel
21	Na in particulate matter			91	N in fuel
22	Mg in particulate matter	59	fuel density	92	S in fuel
23	K in particulate matter	60	fuel viscosity	93	aromatics in fuel
24	Cl in particulate matter	61	fuel cetane index	94	olefins in fuel
25	Zn in particulate matter	62	fuel flash point	95	paraffins in fuel
26	Cu in particulate matter	63	IBP by D-86	96	gum in fuel
27	Ni in particulate matter	64	5% point by D-86		
28	Fe in particulate matter	65	10% point by D-86	"none"	schedule avg. speed
29	Ba in particulate matter	66	20% point by D-86	"none"	schedule speed $s_v/\bar{v}$
30	Ca in particulate matter	67	30% point by D-86	"none"	schedule % idle time
31	(particulate) o-cresol[a]	68	40% point by D-86	"none"	schedule stops/h
32	(particulate) p-cresol	69	50% point by D-86		

[a] plus salicylaldehyde
[b] plus 2,5-xylenol
[c] plus 3,5-xylenol
[d] plus acrolein and propanal

C. Analysis of Fuel Variables

This phase of project activity had several goals. It was of interest to determine means and standard deviations of the fuel variables among the five test fuels, thereby providing insight into significance of variability. It was also necessary to obtain fuel-fuel correlations to determine the degree of interdependence of the fuel variables. It was also a goal to attempt to reduce the number of fuel variables to a few linearly independent, highly significant ones by either elimination or combination. The resulting smaller set of fuel variables was planned for use in analyses of fuel effects on emissions.

Basic statistics for the fuel variables are presented in Table 46, showing most significant variability for (in order of decreasing coefficient of variation) gum, nitrogen, olefins, sulfur, aromatics, flash point, and viscosity. These seven variables would likely have been preferentially included in multiple regressions of emissions against fuel variables had such regressions been conducted, even if their physical significance were in doubt. Of these variables, gum, nitrogen, and olefins may contain substantial random variability due to measurement error. Such errors would be especially important for nitrogen and olefins due to their possible relationships to emission variables. Fuel variables displaying least significant variability (in order of increasing coefficient of variation) are carbon, density, hydrogen, and cetane index; but boiling points by D86 had a average coefficient of variation of 0.0846, and those by D2887 had an average coefficient of variation of 0.0912. The measurement accuracies of carbon, density, and hydrogen are considered to be good, and cetane index is a calculated statistic depending on fuel density and 50% point(26). The low variability of fuel carbon, density, hydrogen, and cetane index among the test fuels means that if emissions-fuel regressions had been conducted, these four fuel variables would have had to correlate very strongly with emission variables in order to be included in the equations.

Negative skewness (γ_1) values in Table 46 indicate a longer "tail" for the distributions on the left (toward lower numbers). Zero skewness indicates a distribution symmetrical about the central maximum. In terms of the data presented here, negative skewness for nearly all the fuel variables generally means that one value was considerably lower than the other four. Positive skewness generally means that one value was higher than the other four. Positive skewness for variable 76 resulted from a high IBP for 2D emissions test fuel, EM-238-F. Positive skewness for carbon and nitrogen resulted from high values for "minimum quality" No. 2 fuel EM-241-F. The small positive skewness for aromatics resulted mainly from higher values for fuels EM-238-F and EM-241-F. Positive skewness for olefins resulted from a comparatively high value for No. 1 fuel, EM-240-F.

Kurtosis is a measure of the "peakiness" of a distribution, with the value of this statistic (γ_2) for a standard normal distribution being $\gamma_2 = 3.0$. Kurtosis values over 3 show stronger peaking tendencies, while

TABLE 46. BASIC STATISTICS FOR FUEL VARIABLES (59-96)

Fuel variable no.	Fuel variable name	mean	standard deviation	coefficient of variation	γ_1= skewness	γ_2= kurtosis
V59	density	0.8374	0.0185	0.0221	-0.5610	2.2624
V60	viscosity	2.3380	0.4737	0.2026	-1.3930	4.0319
V61	cetane index	47.9000	3.6146	0.0755	-0.4031	2.4704
V62	flash point	72.6000	16.4329	0.2263	-0.1139	1.7425
V63	IBP(D86)	181.0000	10.1760	0.0562	-1.0411	2.7770
V64	5% (D86)	-------[a]	------[a]	-----[a]	------[a]	-----[a]
V65	10%(D86)	207.8000	13.5424	0.0652	-1.4629	3.2007
V66	20%(D86)	217.6000	16.0594	0.0738	-1.4205	3.1470
V67	30%(D86)	226.6000	18.7226	0.0826	-1.3749	3.0832
V68	40%(D86)	236.6000	20.5261	0.0868	-1.4590	3.1963
V69	50%(D86)	245.4000	22.3651	0.0911	-1.4866	3.2314
V70	60%(D86)	254.0000	23.7373	0.0935	-1.4671	3.2054
V71	70%(D86)	263.6000	25.1489	0.0954	-1.4380	3.1680
V72	80%(D86)	276.4000	26.4884	0.0958	-1.4602	3.1970
V73	90%(D86)	291.0000	26.9606	0.0926	-1.4103	3.1454
V74	95%(D86)	304.2000	28.7778	0.0946	-1.2331	2.9420
V75	EP (D86)	321.6000	28.1540	0.0875	-1.1798	2.8891
V76	IBP(D2887)	134.6000	8.3789	0.0623	0.3342	1.9451
V77	5% (D2887)	186.2000	12.9937	0.0698	-1.0042	2.8073
V78	10%(D2887)	200.4000	12.8717	0.0642	-1.4417	3.1735
V79	20%(D2887)	221.6000	19.2131	0.0867	-1.0501	2.6154
V80	30%(D2887)	241.4000	22.0830	0.0915	-1.4126	3.1337
V81	40%(D2887)	258.8000	26.6316	0.1029	-1.4771	3.2177
V82	50%(D2887)	271.0000	27.7006	0.1022	-1.4875	3.2331
V83	60%(D2887)	282.4000	27.8942	0.0988	-1.4894	3.2364
V84	70%(D2887)	300.2000	30.0162	0.1000	-1.4362	3.1719
V85	80%(D2887)	320.4000	34.6523	0.1082	-1.4427	3.1788
V86	90%(D2887)	342.2000	35.0516	0.1024	-1.4442	3.1800
V87	95%(D2887)	356.4000	36.3611	0.1020	-1.4048	3.1297
V88	EP (D2887)	394.6000	37.5810	0.0952	-0.8956	2.6489
V89	carbon	86.7200	0.4648	0.0054	0.5267	4.3836
V90	hydrogen	13.0800	0.4943	0.0378	-0.2837	1.8855
V91	nitrogen	0.0096	0.0073	0.7604	1.4189	3.1329
V92	sulfur	0.2280	0.1028	0.4509	-0.8910	2.6943
V93	aromatics	22.2800	8.9100	0.3999	0.1528	1.4013
V94	olefins	1.5200	0.9902	0.6514	1.2062	2.7874
V95	paraffins	76.2000	8.6046	0.1129	-0.1542	1.4309
V96	gum	6.5400	5.0555	0.7730	-0.3123	1.3785

[a] insufficient data

values under 3 indicate flatter distributions. Kurtosis values near 3 dominate the fuel data, especially the boiling ranges. Notably "peaky" distributions ($\gamma_2 > 4$) include those for viscosity and carbon; while notably flat distributions ($\gamma_2 < 2$) other than one boiling point include flash point, hydrogen, aromatics, paraffins, and gum.

To find out how strong the linear relationships among the fuel variables were, a complete fuel-fuel correlation matrix was run (excluding variable 64, for which only one data point was available). The complete correlation matrix is given in Appendix H, pages H-2 through H-9. Some of these pairwise correlations are of particular interest including those between corresponding boiling percentiles by two analysis methods, i.e., variables 63 through 75 against variables 76 through 88, respectively. A table of these boiling percentile correlations has been extracted from Appendix H, and is presented as Table 47. With the exception of IBP, all correlations for corresponding boiling percentiles by the two methods are above +0.965; all the correlations except two are +0.990 or above. IBP by D2887 (gas chromatograph) was a comparatively low correlator with all the D86 boiling points, presumably because the gas chromatograph was more sensitive to light ends than was thermal distillation. The high overall correlations indicate that except for IBP, the two sets of data are essentially interchangeable regarding their usefulness as independent variables in studying fuel effects on emissions. If the percentiles were linearly independent of one another, correlations for corresponding percentiles by the two methods would be high (var's. 78 vs 65, var's. 79 vs 66, etc.); but other correlations in Table 47 would be low. It should be noted, however, that this usefulness is compromised greatly due to linear dependencies between boiling percentiles for each analysis method taken above.

The linear dependency problem in the boiling range data is illustrated by Table 48, a summary of correlations between boiling percentiles for the gas chromatograph data alone (ASTM D2887, variables 76 through 88). With the exceptions of correlations with IBP (var. 76) and a few of the correlations with 20% point (var. 79), virtually all the non-corresponding pairs have correlations (r) in excess of +0.9. With dependencies as strong as these, it is virtually impossible to use more than one boiling percentile as an independent variable in studying fuel effects on emissions. It is almost certainly the case that for other groups of fuels, the correlations would be different. It is considered unlikely, however, that really low correlations would exist for any groups of fuels distilled and refined by conventional processes.

Regarding fuel variables other than boiling percentiles, most of them exhibit strong correlations with one or more additional variables. To simplify this discussion, it was decided to temporarily characterize fuel boiling range by three points: IBP, 30% point, and end point. All the other boiling percentiles are strongly correlated with one or more of these points, so no relationships of significance were being overlooked. With this change, the remaining high correlations can be presented at once in Table 49. Paraffins (variable 95) was omitted due to

TABLE 47. CORRELATIONS BETWEEN BOILING PERCENTILES OBTAINED BY TWO ANALYSIS METHODS

ASTM D86 (thermal distillation) boiling range	Correlation coefficient (r) by ASTM D2887 (gas chromatograph simulated) boiling range												
	IBP var.76	5% var.77	10% var.78	20% var.79	30% var.80	40% var.81	50% var.82	60% var.83	70% var.84	80% var.85	90% var.86	95% var.87	LP var.88
IBP (var.63)	0.766	0.990	0.910	0.776	0.908	0.951	0.952	0.953	0.967	0.967	0.971	0.977	0.998
10% (var.65)	0.571	0.909	0.999	0.960	0.998	0.995	0.994	0.991	0.976	0.977	0.979	0.971	0.898
20% (var.66)	0.532	0.895	0.998	0.966	0.999	0.991	0.989	0.984	0.966	0.968	0.971	0.963	0.893
30% (var.67)	0.531	0.889	0.998	0.970	0.999	0.988	0.985	0.979	0.958	0.959	0.961	0.951	0.884
40% (var.68)	0.586	0.913	1.000	0.958	0.998	0.996	0.994	0.992	0.977	0.078	0.978	0.970	0.899
50% (var.69)	0.630	0.937	0.996	0.938	0.993	1.000	0.999	0.998	0.989	0.989	0.990	0.984	0.922
60% (var.70)	0.663	0.955	0.989	0.917	0.987	1.000	0.999	0.998	0.993	0.993	0.994	0.990	0.944
70% (var.71)	0.685	0.963	0.984	0.906	0.982	0.998	0.997	0.996	0.993	0.992	0.993	0.989	0.949
80% (var.72)	0.690	0.955	0.987	0.914	0.981	0.996	0.997	0.998	0.994	0.993	0.992	0.986	0.930
90% (var.73)	0.718	0.977	0.971	0.876	0.967	0.992	0.994	0.994	0.997	0.997	0.998	0.998	0.966
95% (var.74)	0.723	0.983	0.945	0.833	0.944	0.975	0.976	0.974	0.981	0.981	0.985	0.988	0.990
EP (var.75)	0.732	0.985	0.935	0.818	0.935	0.969	0.969	0.968	0.976	0.977	0.981	0.985	0.993

TABLE 48. CORRELATIONS BETWEEN BOILING PERCENTIELS BY ASTM-D2887

Boiling percentiles	Correlation coefficient (r) by boiling percentiles												
	IBP var.76	5% var.77	10% var.78	20% var.79	30% var.80	40% var.81	50% var.82	60% var.83	70% var.84	80% var.85	90% var.86	95% var.87	EP var.88
IBP (var.76)	1.000	----[a]	----[a]	----[a]	----[a]	----[a]	----[a]	----[a]	----[a]	----[a]	----[a]	----[a]	----[a]
5% (var.77)	0.837	1.000	----[a]	----[a]	----[a]	----[a]	----[a]	----[a]	----[a]	----[a]	----[a]	----[a]	----[a]
10% (var.78)	0.562	0.902	1.000	----[a]	----[a]	----[a]	----[a]	----[a]	----[a]	----[a]	----[a]	----[a]	----[a]
20% (var.79)	0.347	0.759	0.966	1.000	----[a]	----[a]	----[a]	----[a]	----[a]	----[a]	----[a]	----[a]	----[a]
30% (var.80)	0.540	0.895	0.999	0.969	1.000	----[a]	----[a]	----[a]	----[a]	----[a]	----[a]	----[a]	----[a]
40% (var.81)	0.640	0.945	0.993	0.929	0.991	1.000	----[a]	----[a]	----[a]	----[a]	----[a]	----[a]	----[a]
50% (var.82)	0.652	0.948	0.992	0.924	0.989	1.000	1.000	----[a]	----[a]	----[a]	----[a]	----[a]	----[a]
60% (var.83)	0.670	0.953	0.988	0.916	0.984	0.998	0.999	1.000	----[a]	----[a]	----[a]	----[a]	----[a]
70% (var.84)	0.726	0.972	0.971	0.879	0.965	0.990	0.993	0.996	1.000	----[a]	----[a]	----[a]	----[a]
80% (var.85)	0.717	0.970	0.972	0.881	0.966	0.990	0.994	0.996	1.000	1.000	----[a]	----[a]	----[a]
90% (var.86)	0.705	0.969	0.973	0.883	0.968	0.992	0.994	0.996	0.999	1.000	1.000	----[a]	----[a]
95% (var.87)	0.717	0.975	0.964	0.865	0.958	0.987	0.990	0.992	0.997	0.998	0.999	1.000	----[a]
EP (var.88)	0.766	0.984	0.889	0.749	0.889	0.934	0.934	0.934	0.949	0.950	0.954	0.962	1.000

[a] redundant values omitted

TABLE 49. STRONG PAIRWISE CORRELATIONS BETWEEN SELECTED FUEL VARIABLES ($r \geq 0.8$)[a]

Fuel variables	Correlation coefficient r (if ≥ 0.8)[a]													
	dens. (59)	visc. (60)	cet.ind. (61)	flash (62)	IBP (76)	30% (80)	EP (88)	C (89)	H (90)	N (91)	S (92)	aro. (93)	ole. (94)	gum. (96)
density(59)	1.000	-----[b]	----[b]	----[b]	----[b]	----[b]	----[b]	----[b]	----[b]	----[b]	----[b]	----[b]	----[b]	----[b]
viscosity(60)	0.805	1.000	----[b]	----[b]	----[b]	----[b]	----[b]	----[b]	----[b]	----[b]	----[b]	----[b]	----[b]	----[b]
cetane index(61)			1.000	----[b]	----[b]	----[b]	----[b]	----[b]	----[b]	----[b]	----[b]	----[b]	----[b]	----[b]
flash pt.(62)		0.842		1.000	----[b]	----[b]	----[b]	----[b]	----[b]	----[b]	----[b]	----[b]	----[b]	----[b]
IBP(76)					1.000	----[b]	----[b]	----[b]	----[b]	----[b]	----[b]	----[b]	----[b]	----[b]
30%(80)	0.902	0.969				1.000	----[b]	----[b]	----[b]	----[b]	----[b]	----[b]	----[b]	----[b]
EP(88)		0.958		0.937		0.889	1.000	----[b]	----[b]	----[b]	----[b]	----[b]	----[b]	----[b]
carbon(89)	0.909							1.000	----[b]	----[b]	----[b]	----[b]	----[b]	----[b]
hydrogen(90)	-0.941							-0.993	1.000	----[b]	----[b]	----[b]	----[b]	----[b]
nitrogen(91)										1.000	----[b]	----[b]	----[b]	----[b]
sulfur(92)[c]		0.924			0.827		0.964				1.000	----[b]	----[b]	----[b]
aromatics(93)	0.858							0.934	-0.956			1.000	----[b]	----[b]
olefins(94)		-0.924				-0.960							1.000	----[b]
gum(96)	0.945							0.928	-0.959			0.947		1.000

[a] paraffins(95) omitted due to its definition (100-aromatics-olefins)

[b] redundant values omitted

[c] doping of fuel EM-239-F to increase sulfur content to "national average" affected these results

its obvious strong dependence on aromatics (93) and olefins (94). Of the variables listed in Table 49, only two exhibit no correlations (r) of magnitude 0.8 or more (cetane index, 61, and nitrogen, 91). Three additional variables which are somewhat linearly independent of each other and of cetane and nitrogen ($|r|<0.8$) are sulfur(92), aromatics(93), and olefins(94). At least one of these five fuel variables (61, 91, 92, 93 and 94) is strongly correlated with each of the remaining fuel variables, so the remaining ones could be represented to some extent by the five variables listed, if necessary. This result is the furthest extent to which the process of elimination of variables can be pushed by analysis of pairwise correlations.

In order to determine whether or not the five fuel variables selected for minimum pairwide correlations possessed multi-variable linear combinations (multi-collinearity), latent roots and latent vectors were calculated for the correlation matrix formed with the five variables. The computer output from this analysis is given in Appendix H, pages H-10 and H-11. The fifth (smallest) latent root was nearly zero, as shown on page H-10, making the correlation matrix singular. The corresponding latent vector indicated the existence of a linear combination among cetane index, sulfur, and aromatics, in spite of the fact that the highest pairwise correlation (r) between any two of these variables was less than 0.73. The inverse of the correlation matrix is shown on page H-11. Several other combinations of fuel variables considered to represent most of the physical fuel variability were also examined to determine whether or not they were linearly related. In all cases, some multi-collinearity existed; and thus no way was found to generate a representative small set of fuel variables from the entire set.

The final look at the fuel data above in this subsection consists of a factor analysis conducted on all the fuel variables except boiling range by ASTM D86 (variables 63 through 75). Computer output from this analysis is given in Appendix H, pages H-12 through H-15. The most useful result of the analysis is the "varimax rotated factor matrix" on page H-15, showing that virtually all the mathematical fuel variability can be characterized in three fuel factors. Factor 1 is high in (positive) viscosity, sulfur, and boiling percentiles above IBP, and high in negative olefins. Factor 2 is high in (positive) carbon, nitrogen, aromatics, and gum, and high in negative cetane, hydrogen, and paraffins. Factor 3 is highest in (positive) flash point and IBP, although it is not as well-defined as the other two. Factor 1 can perhaps best be characterized as "heavy ends - olefins", Factor 2 as "aromatics + nitrogen", and Factor 3 as "light ends". The compositions of these factors suggest that the five fuel variables chosen as most highly uncorrelated via analysis of pairwise correlations were indeed indicative of most of the mathematical fuel variability in addition to their having a good chance of being physically related to emissions production.

D. Relationships Between Emissions Variables

Rather than analyzing all 49 emissions variables for linear relationships, it was decided to analyze a selected set of nine (in mass/unit time) considered most important. They included: total particulate mass; solubles; sulfur; sulfate; BaP; percent of particulate mass other than C, H, N, and S; hydrocarbons; CO; and NO_x. A complete correlation matrix for these nine variables is presented on page H-16 for the Mercedes 240D, and a similar table is given on page H-17 for the VW Rabbit Diesel. Four of the nine variables (solubles, BaP, 100-CHNS, and HC) exhibited no pairwise correlations ($|r|$) over 0.701 with other emissions variables for either vehicle. Correlations for the five remaining variables are summarized in Table 50, indicating both similarities and differences between the vehicles.

TABLE 50. SUMMARY OF SELECTED STRONG EMISSIONS - EMISSIONS CORRELATIONS

Vehicle	Emissions variables	Correlation coefficient (r) by emissions variable				
		particulate mass (var.4)	sulfur (var.10)	sulfate (var.11)	CO (var.41)	NO_x (var.42)
Mercedes 240D	particulate mass (4)	1.000	----[a]	----[a]	----[a]	----[a]
	sulfur (10)	0.863	1.000	----[a]	----[a]	----[a]
	sulfate (11)	0.895	0.926	1.000	----[a]	----[a]
	CO (41)	0.890	0.735	0.748	1.000	----[a]
	NO_x (42)	0.890	0.781	0.826	0.941	1.000
VW Rabbit Diesel	particulate mass (4)	1.000	----[a]	----[a]	----[a]	----[a]
	sulfur (10)	0.769	1.000	----[a]	----[a]	----[a]
	sulfate (11)	0.848	0.921	1.000	----[a]	----[a]
	CO (41)	0.712	0.380	0.462	1.000	----[a]
	NO_x (42)	0.734	0.650	0.676	0.666	1.000

[a] redundant values omitted

Sulfur and sulfate correlated strongly with each other for both vehicles, as expected. Particulate mass rate correlated quite strongly with the other four emissions variables for both vehicles, although more consistently so for the Mercedes. All correlations were lower for the VW than for the Mercedes, especially those involving CO and NO_x. The fact that all the correlation coefficients in Table 50 are positive and that they were calculated from time-based data suggests that they all have a dependence on a common time-related operating variable, such as fuel rate (this relationship is considered a fact for sulfur and sulfate).

E. Relationships Between Emissions and Fuel Variables

In a study such as this one, involving emissions measured while a number of fuels were in use, it would be ideal to be able to construct linear regressions to predict emissions from fuel variables. Previous report subsections have shown, however, that the existing data are much less than ideal for the purposes of constructing most emissions-fuel regression models. Some of the reasons for this problem are strong pairwise linear correlations between fuel variables, strong multicollinear relationships between groups of fuel variables, and a small effective data base when the sample is restricted to a single vehicle and a single operating procedure.

Given the fact that construction of most emissions-fuel linear prediction models is not feasible due to overall program design and intent, alternative ways of documenting relationships between emissions and fuels, and between emissions and operating schedules, were sought. The major end product of this search was the use of analysis of variance and multiple comparisons, along with presentation of strongest pairwise correlations, as described in subsection IX.A. Results are given in this manner by emissions variable and by vehicle beginning with Table 51.

Table 51 shows wider variation in mean particulate mass rate (variable 4) by operating schedule than by fuel. Since particulate mass rate is expressed in time units, these results are as expected. Note that the fuel variables most highly correlated (pairwise) with particulate mass appear to be +density, -hydrogen, +carbon, and +gum, all of which are highly correlated with one another and appear to act as the "heavy ends" of the fuel. Variation in order, and random inclusion of some unexpected, highly correlated variables is not important in this analysis. Note that rank-ordered means by fuel are the same for both vehicles, and that EM-240-F No. 1 fuel and EM-241-F "minimum quality" No. 2 are the only fuels which stand out from the other No. 2 fuels in either direction. In this table, rank-ordered means by operating schedule are also identical for both vehicles, which is really an indicator of the strength of schedule difference. Note also that the mean for the 1975 FTP is the median figure in each case (overall mean for the Mercedes was 9.9046, and that for the VW was 7.7367).

Table 52 shows somewhat wider variation in mean organic solubles by fuel than by operating schedule for the Mercedes, and the opposite situation for the VW. Ranges of variation in mean solubles were smaller than the corresponding ranges for total particulate matter. Olefins, 20% point, and nitrogen were the only fuel variables occurring for both vehicles among the highest correlators, and they all appeared with different signs for the two vehicles. Olefins(+), -20% point, and -10% point occurred most frequently for the Mercedes, while -IBP and -flash point occurred most frequently for the VW.

Comparison and correlation data in Table 53 for sulfur indicate that fuel sulfur was among the three strongest correlating fuel variables for only 4 (Mercedes) to 6 (VW) of the nine operating schedules. Given that the lowest correlation (r) between variables 10 and 92 for the Mercedes was +0.760, and that the corresponding value for the VW was +0.889, the remarkably high associations between fuel variables is amply demonstrated. This same situation occurred for sulfate in Table 54, with fuel sulfur among the three strongest correlating fuel variables for only 4 of the nine operating schedules for both vehicles. Rank ordering of means according to both operating schedules and fuels was very similar for both vehicles and for both sulfur and sulfate.

TABLE 51. MULTIPLE COMPARISONS OF MEANS AND STRONGEST PAIRWISE FUEL VARIABLE CORRELATORS FOR EMISSIONS VARIABLES: PARTICULATE MASS (V4), g/h

Mercedes 240D

Inverse rank-ordered		Pairwise correlations between particulate mass (V4) and fuel variables for indicated operating schedules					
operating schedule	mean value of variable[a]	highest	r	2nd highest	r	3rd highest	r
Idle	2.8720	dens. (59)	0.989	H (90)	-0.926	20% (79)	0.921
NYCC	6.6696	dens. (59)	0.968	H (90)	-0.916	gum (96)	0.888
50 km/h	6.8700	dens. (59)	0.959	gum (96)	0.955	40% (81)	0.894
Hot FTP	9.4506	dens. (59)	0.997	gum (96)	0.942	H (90)	-0.938
1975 FTP	9.7526	dens. (59)	0.987	H (90)	-0.965	C (89)	0.941
Cold FTP	10.1427	H (90)	-0.975	C (89)	0.966	dens. (59)	0.953
CFDS	12.4522	gum (96)	0.949	dens. (59)	0.933	aro. (93)	0.912
FET	15.2404	H (90)	-0.968	dens. (59)	0.962	C (89)	0.948
85 km/h	15.6910	dens. (59)	0.854	H (90)	-0.793	10% (78)	0.772

Inverse rank-ordered	
fuel	mean value of variable[a]
EM-240-F	7.2009
EM-242-F	9.4682
EM-239-F	9.7704
EM-238-F	10.7776
EM-241-F	12.3058

VW Rabbit Diesel

Inverse rank-ordered		Pairwise correlations between particulate mass (V4) and fuel variables for indicated operating schedules					
operating schedule	mean-value of variable[a]	highest	r	2nd highest	r	3rd highest	r
Idle	1.9464	20% (79)	0.956	dens. (59)	0.946	30% (80)	0.926
NYCC	4.3069	20% (79)	0.924	dens. (59)	0.874	10% (78)	0.866
50 km/h	4.5400	C (89)	0.941	N (91)	0.924	H (90)	-0.917
Hot FTP	6.0088	H (90)	0.989	dens. (59)	0.974	C (89)	0.968
1975 FTP	7.4812	C (89)	0.945	N (91)	0.938	H (90)	-0.916
Cold FTP	9.4191	N (91)	0.969	C (89)	0.903	H (90)	-0.862
CFDS	10.3713	gum (96)	0.993	aro. (93)	0.977	H (90)	-0.973
FET	12.4497	IBP (76)	0.838	S (92)	0.784	70% (84)	0.727
85 km/h	13.1070	dens. (59)	0.918	10% (78)	0.900	60% (83)	0.895

Inverse rank-ordered	
fuel	mean value of variable[a]
EM-240-F	5.6844
EM-242-F	7.1148
EM-239-F	7.2478
EM-238-F	7.9012
EM-241-F	10.7354

[a] brackets surround means not significantly different at the 0.05 level

TABLE 52. MULTIPLE COMPARISONS OF MEANS AND STRONGEST PAIRWISE FUEL VARIABLE CORRELATORS FOR EMISSIONS VARIABLES: SOLUBLES (V6), % of particulate mass

Mercedes 240D

Inverse rank-ordered		Pairwise correlations between solubles (V6) and fuel variables for indicated operating schedules					
operating schedule	mean value of variable[a]	highest	r	2nd highest	r	3rd highest	r
FET	6.5400	ole. (94)	0.838	70% (84)	-0.815	80% (85)	-0.814
85 km/h	7.4000	ole. (94)	0.715	70% (84)	-0.670	60% (83)	-0.669
CFDS	7.7000	dens. (59)	-0.896	20% (79)	-0.895	10% (78)	-0.876
50 km/h	8.7800	20% (79)	-0.857	dens. (59)	-0.800	N (91)	-0.796
Idle	9.2000	20% (79)	-0.993	10% (78)	-0.979	30% (80)	-0.977
Hot FTP	9.7400	N (91)	-0.803	20% (79)	-0.778	ole. (94)	0.717
1975 FTP	9.9000	20% (79)	-0.838	ole. (94)	0.779	N (91)	-0.778
Cold FTP	10.0800	20% (79)	-0.940	ole. (94)	0.879	10% (78)	-0.860
NYCC	10.4000	ole. (94)	0.968	10% (78)	-0.959	10% (78)	-0.944

Inverse rank-ordered	
fuel	mean value of variable[a]
EM-241-F	5.6667
EM-242-F	6.5333
EM-239-F	8.4778
EM-238-F	9.5667
EM-240-F	14.0556

VW Rabbit Diesel

Inverse rank-ordered		Pairwise correlations between solubles (V6) and fuel variables for indicated operating schedules					
operating schedule	mean value of variable[a]	highest	r	2nd highest	r	3rd highest	r
Cold FTP	12.4600	gum (96)	-0.896	H (90)	0.819	C (89)	-0.814
FET	13.4000	IBP (76)	-0.871	S (92)	-0.698	flash (62)	-0.692
1975 FTP	13.6400	flash (62)	-0.801	EP (88)	-0.706	IBP (76)	-0.703
85 km/h	13.8200	cetane[b] (61)	-0.989	par. (95)	-0.854	C (89)	0.849
Hot FTP	14.5400	IBP (76)	-0.696	N (91)	0.692	flash (62)	-0.685
CFDS	14.5400	flash (62)	-0.576	N (91)	0.574	cetane[b] (61)	-0.560
Idle	15.1400	IBP (76)	-0.946	S (92)	-0.793	5% (77)	-0.757
50 km/h	17.0000	IBP (76)	-0.457	ole. (94)	-0.379	20% (79)	0.368
NYCC	18.0400	IBP (76)	-0.625	cetane[b] (61)	-0.289	S (92)	-0.275

Inverse rank-ordered	
fuel	mean value of variable[a]
EM-238-F	12.2000
EM-242-F	12.7444
EM-240-F	15.8333
EM-241-F	15.4333
EM-239-F	16.4444

[a] brackets surround means not significantly different at the 0.05 level

[b] cetane index, not cetane number

TABLE 53. MULTIPLE COMPARISONS OF MEANS AND STRONGEST PAIRWISE FUEL VARIABLE CORRELATORS FOR EMISSIONS VARIABLES: SULFUR (V10), mg/h

Mercedes 240D

Inverse rank-ordered		Pairwise correlations between sulfur (V10) and fuel variables for indicated operating schedules					
operating schedule	mean value of variable[a]	highest	r	2nd highest	r	3rd highest	r
Idle	21.9400	S (92)	0.901	IBP (76)	0.859	5% (77)	0.839
NYCC	37.9758	dens. (54)	0.832	10% (78)	0.830	20% (79)	0.820
50 km/h	47.5000	70% (84)	0.887	60% (83)	0.883	S (92)	0.881
Hot FTP	86.1375	60% (83)	0.953	70% (84)	0.948	10% (78)	0.948[b]
1975 FTP	91.8003	70% (84)	0.951	60% (83)	0.951	80% (85)	0.947
Cold FTP	99.2878	70% (84)	0.948	80% (85)	0.943	60% (83)	0.940
CFDS	188.2940	70% (84)	0.872	80% (85)	0.866	60% (83)	0.858
FET	188.8387	70% (84)	0.874	S (92)	0.868	80% (85)	0.868
85 km/h	236.3000	70% (84)	0.929	80% (85)	0.926	S (92)	0.918

Inverse rank-ordered	
fuel	mean value of variable[a]
EM-240-F	26.1705
EM-239-F	93.6937
EM-238-F	137.9802
EM-241-F	143.6908
EM-242-F	152.9504

VW Rabbit Diesel

Inverse rank-ordered		Pairwise correlations between sulfur (V10) and fuel variables for indicated operating schedules					
operating schedule	mean value of variable[a]	highest	r	2nd highest	r	3rd highest	r
50 km/h	12.7000	S (92)	0.956	70% (84)	0.943	5% (77)	0.938
Idle	12.9000	70% (84)	0.976	60% (83)	0.974	40% (81)	0.974
NYCC	14.2807	S (92)	0.991	5% (77)	0.988	EP (88)	0.973
Hot FTP	46.1833	S (92)	0.945	5% (77)	0.929	70% (84)	0.929
1975 FTP	53.1045	70% (84)	0.947	80% (85)	0.944	S (92)	0.938
Cold FTP	62.2908	70% (84)	0.937	60% (83)	0.937	80% (85)	0.933
FET	101.7062	S (92)	0.970	5% (77)	0.953	IBP (76)	0.925
CFDS	119.2710	S (92)	0.977	5% (77)	0.968	70% (84)	0.951
85 km/h	131.5800	5% (77)	0.915	95% (87)	0.897	95% (87)	0.897

Inverse rank-ordered	
fuel	mean value of variable[a]
EM-240-F	16.2621
EM-239-F	58.1038
EM-241-F	65.9147
DM-242-F	78.0424
EM-238-F	89.4639

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[a] brackets surround means not significantly different at the 0.05 level

[b] variable 82 (50% point) had equal r value

TABLE 54. MULTIPLE COMPARISONS OF MEANS AND STRONGEST PAIRWISE FUEL VARIABLE CORRELATORS FOR EMISSIONS VARIABLES: SULFATE (V 11), mg/h

Mercedes 240D

Inverse rank-ordered		Pairwise correlations between sulfate (V11) and fuel variables for indicated operating schedules					
operating schedule	mean value of variable[a]	highest	r	2nd highest	r	3rd highest	r
Idle	49.4000	S (92)	0.987	5% (77)	0.966	70% (84)	0.930
NYCC	84.5928	S (92)	0.971	5% (77)	0.960	IBP (76)	0.947
50 km/h	112.1000	S (92)	0.986	5% (77)	0.965	70% (84)	0.929
Hot FTP	222.1076	60% (83)	0.933	70% (84)	0.928	10% (78)	0.925
1975 FTP	226.1974	10% (78)	0.969	60% (83)	0.969	50% (82)	0.965
Cold FTP	231.5456	10% (78)	0.973	30% (80)	0.972	40% (81)	0.970
CFDS	503.4600	10% (78)	0.972	60% (83)	0.966	50% (82)	0.963
85 km/h	601.8000	70% (84)	0.996	80% (85)	0.995	95% (87)	0.993
FET	668.2224	S (92)	0.921	dens. (59)	0.909	5% (77)	0.901

Inverse rank-ordered	
fuel	mean value of variable[a]
EM-240-F	78.0531
EM-239-F	308.6553
EM-242-F	332.6240
EM-241-F	385.2689
EM-238-F	395.0797

VW Rabbit Diesel

Inverse rank-ordered		Pairwise correlations between sulfate (V11) and fuel variables for indicated operating schedules					
operating schedule	mean value of variable[a]	highest	r	2nd highest	r	3rd highest	r
50 km/h	49.2000	S (92)	0.986	5% (77)	0.970	70% (84)	0.945
Idle	58.0000	dens. (59)	0.904	C (89)	0.888	20% (79)	0.887
NYCC	61.3980	H (90)	-0.860	aro. (93)	0.859	C (89)	0.953
Hot FTP	120.1772	gum (96)	0.961	dens. (59)	0.959	40% (81)	0.892
1975 FTP	162.5224	H (90)	-0.981	dens. (59)	0.968	C (89)	0.955
Cold FTP	213.2988	H (90)	-0.978	C (89)	0.967	aro. (93)	0.945
CFDS	372.5604	S (92)	0.981	5% (77)	0.979	EP (88)	0.962
85 km/h	380.8000	5% (77)	0.994	EP (88)	0.992	S (92)	0.985
FET	386.0496	S (92)	0.911	70% (84)	0.903	80% (85)	0.902

Inverse rank-ordered	
fuel	mean value of variable[a]
EM-240-F	70.2408
EM-239-F	202.5864
EM-242-F	211.5410
EM-241-F	251.2814
EM-238-F	266.5762

[a] brackets surround means not significantly different at the 0.05 level

Data on BaP are presented in Table 55, showing fairly consistent ranks according to fuel, but little other agreement. Fuel "+carbon" occurred most often as a strong pairwise correlator overall, and other measures of fuel hydrogen/carbon ratio (-cetane index, -hydrogen, -paraffins, +aromatics) generally supported this correlation. The rest of the results were mixed and not very informative, except that +nitrogen appeared a total of four times as a strong correlator.

Total variability in mean values of variable 35, percent of particulate not analyzed as carbon, hydrogen, nitrogen, or sulfur, was somewhat lower than most of the other particulate variables. The range of means by fuel in Table 56 was about equal for the two vehicles, but the range by operating schedule was considerably wider for the VW. The most dramatic results were the high (100-CHNS) values for the VW at light loads (last 2 conditions tabulated), which also produced low total particulate and relatively high percentages of metallic elements (variables 13-30, see Appendix p. G-15 or G-21). Cetane index was the fuel variable occurring most often as a strong correlator, but it was a positive correlator for the Mercedes and (mostly) a negative correlator for the VW. Other variables occurring comparatively often were +IBP, (mostly) +nitrogen, and (mixed signs) carbon.

The first of the gaseous emissions analyzed was total hydrocarbons, shown in Table 57. More variation in mean HC occurred for the VW than for the Mercedes by both operating schedule and fuel. HC was notably higher for the VW when EM-241-F "minimum quality" No. 2 fuel was in use. Fuel variables occurring most often as strong correlators with HC for the Mercedes were +carbon, -hydrogen, +density, and +flash point. The corresponding list for the VW includes +carbon, +nitrogen (probably a mathematical association), and -cetane index. Generally speaking, all these correlations could be classed as "+heavy ends + aromatics", or something similar.

With the exception of idle CO emissions from the Mercedes, ranges and rank ordering of means by schedule and fuel in Table 58 are quite similar for both vehicles. The VW showed a somewhat larger range of means by fuel than the Mercedes, primarily due to the high mean for fuel EM-241-F. Fuel variables highly correlated with CO for the Mercedes were +nitrogen (or an associated variable), +carbon, -olefins, +20% point, and -IBP. The corresponding list for the VW includes +nitrogen (or an associated variable), +carbon, and -cetane index.

The NO_x emission mean values shown in Table 59 have a large range and parallel variation by operating schedule for the two vehicles, and relatively minor and mixed variation by fuel. Fuel variables, consequently, have more mixed and lower correlations with NO_x than they did with CO. Most important fuel variable correlators for the Mercedes were +nitrogen (or a mathematically associated variable), +20% point, and -cetane index. For the VW, the most important fuel variable correlators were -olefins, and +cetane index. Fuel variable correlations with NO_x are not considered very informative.

TABLE 55. MULTIPLE COMPARISONS OF MEANS AND STRONGEST PAIRWISE FUEL VARIABLE CORRELATORS FOR EMISSIONS VARIABLES: BaP (V12), μg/h

Mercedes 240D

Inverse rank-ordered		Pairwise correlations between BaP (V12) and fuel variables for indicated operating schedules					
operating schedule	mean value of variable[a]	highest	r	2nd highest	r	3rd highest	r
85 km/h	5.3550	ole. (94)	0.988	20% (79)	-0.964	10% (78)	-0.920
FET	8.3566	gum (96)	-0.925	flash (62)	-0.854	dens. (59)	-0.817
50 km/h	8.3800	ole. (94)	-0.610	cetane[b] (61)	0.593	80% (85)	0.537
CFDS	8.7226	IBP (76)	-0.832	S (92)	-0.540	5% (77)	-0.475
Hot FTP	11.5144	C (89)	0.971	aro. (93)	0.934	par. (95)	-0.929
1975 FTP	12.7036	C (89)	0.941	H (90)	-0.904	cetane[b] (61)	-0.900
Cold FTP	14.2828	cetane (61)[b]	-0.909	C (89)	0.890	H (90)	-0.837
Idle	19.8600	C (89)	0.923	N (91)	0.919	cetane[b] (61)	-0.903
NYCC	22.9674	C (89)	0.975	H (90)	-0.955	gum (96)	0.901

Inverse rank-ordered	
fuel	mean value of variable[a]
EM-242-F	8.2906
EM-240-F	9.4295
EM-238-F	10.7611
EM-239-F	13.1523
EM-241-F	20.6702

VW Rabbit Diesel

Inverse rank-ordered		Pairwise correlations between BaP (V12) and fuel variables for indicated operating schedules					
operating schedule	mean value of variable[a]	highest	r	2nd highest	r	3rd highest	r
Idle	3.6200	30% (80)	0.980	10% (78)	0.972	40% (81)	0.968
50 km/h	9.6500	flash (62)	0.960	EP (88)	0.874	dens. (59)	0.801
NYCC	14.8947	40% (81)	0.990	dens. (59)	0.989	50% (82)	0.988
Hot FTP	20.7007	N (91)	0.951	cetane[b] (61)	0.912	C (89)	0.882
85 km/h	27.7100	95% (87)	-0.947	80% (85)	-0.946	90% (86)	-0.946
CFDS	33.3402	visc. (60)	-0.936	95% (87)	-0.935	90% (86)	-0.924
FET	35.9693	visc. (60)	-0.978	30% (80)	-0.971	10% (78)	-0.964
1975 FTP	52.3872	N (91)	0.974	cetane[b] (61)	-0.875	C (89)	0.866
Cold FTP	94.3800	N (91)	0.977	cetane[b] (61)	-0.869	C (89)	0.863

Inverse rank-ordered	
fuel	mean value of variable[a]
EM-242-F	21.0452
EM-238-F	25.0121
EM-239-F	25.8884
EM-240-F	35.5588
EM-241-F	55.0800

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[a] brackets surround means not significantly different at the 0.05 level

[b] cetane index, not cetane number

TABLE 56. MULTIPLE COMPARISONS OF MEANS AND STRONGEST PAIRWISE FUEL VARIABLE CORRELATORS FOR EMISSIONS VARIABLES: 100-CHNS (V35),% of particulate

Mercedes 240D

Inverse rank-ordered		Pairwise correlations between 100-CHNS (V35) and fuel variables for indicated operating schedules					
operating schedule	mean value of variable[a]	highest	r	2nd highest	r	3rd highest	r
50 km/h	15.4560	cetane (61)[b]	0.769	IBP (76)	0.501	par. (95)	0.491
NYCC	17.0040	IBP (76)	0.709	N (91)	0.460	S (92)	0.460
FET	19.2080	70% (84)	0.983	80% (85)	0.980	60% (83)	0.977
Cold FTP	19.2400	20% (79)	0.950	ole. (94)	-0.893	30% (80)	0.876
85 km/h	19.6000	ole. (94)	0.738	20% (79)	-0.626	10% (78)	-0.533
1975 FTP	20.4840	cetane (61)[b]	0.964	N (91)	-0.694	C (89)	-0.632
Hot FTP	21.4200	C (89)	-0.861	cetane[b] (61)	0.825	H (90)	0.803
CFDS	21.5400	C (89)	-0.572	20% (79)	-0.523	H (90)	0.515
Idle	24.6600	IBP (76)	0.849	S (92)	0.632	5% (77)	0.556

Inverse rank-ordered	
fuel	mean value of variable[a]
EM-239-F	16.3767
EM-240-F	16.3922
EM-241-F	19.8833
EM-238-F	22.4389
EM-242-F	24.1378

VW Rabbit Diesel

Inverse rank-ordered		Pairwise correlations between 100-CHNS (V35) and fuel variables for indicated operating schedules					
operating schedule	mean value of variable[a]	highest	r	2nd highest	r	3rd highest	r
85 km/h	16.9400	N (91)	0.524	IBP (76)	0.410	cetane[b] (61)	-0.373
CFDS	23.6600	flash (62)	-0.935	EP (88)	-0.905	5% (77)	-0.874
Hot FTP	23.7800	cetane (61)[b]	-0.960	N (91)	0.879	C (89)	0.736
FET	24.7600	flash (62)	-0.631	visc. (60)	-0.595	ole. (94)	0.556
1975 FTP	24.9488	cetane (61)[b]	-0.846	95% (87)	-0.645	visc. (60)	-0.638
Cold FTP	26.5000	dens. (59)	-0.809	N (91)	-0.771	20% (79)	-0.756
50 km/h	31.8800	N (91)	0.774	cetane[b] (61)	-0.756	flash (62)	-0.667
NYCC	43.4400	N (91)	0.625	par. (95)	-0.606	aro. (93)	0.577
Idle	58.7200	IBP (76)	0.672	cetane[b] (61)	0.634	S (92)	0.478

Inverse rank-ordered	
fuel	mean value of variable[a]
EM-239-F	26.6771
EM-242-F	30.4500
EM-238-F	30.7578
EM-240-F	31.7356
EM-241-F	32.9511

[a] brackets surround means not significantly different at the 0.05 level

[b] cetane index, not cetane number

TABLE 57. MULTIPLE COMPARISONS OF MEANS AND STRONGEST PAIRWISE FUEL VARIABLE CORRELATORS FOR EMISSIONS VARIABLES: HYDROCARBONS (V40), g/h

Mercedes 240D

Inverse rank-ordered		Pairwise correlations between HC (V40) and fuel variables for indicated operating schedules					
operating schedule	mean value of variable[a]	highest	r	2nd highest	r	3rd highest	r
Idle	2.0100	C (89)	0.994	H (90)	-0.992	aro. (93)	0.965
NYCC	2.7790	dens. (59)	0.984	H (90)	-0.983	gum (96)	0.974
50 km/h	3.0000	S (92)	0.959	5% (77)	0.954	EP (88)	0.948
Hot FTP	3.5235	C (89)	0.826	H (90)	-0.776	N (91)	0.760
FET	4.0310	flash (62)	0.988	EP (88)	0.940	visc. (60)	0.886
CFDS	4.2509	EP (88)	0.930	flash (62)	0.927	5% (77)	0.902
1975 FTP	4.5302	20% (79)	0.841	C (89)	0.838	dens. (59)	0.831
85 km/h	5.1000	flash (62)	0.827	IBP (76)	0.745	EP (88)	0.743
Cold FTP	5.2224	C (89)	0.882	dens. (59)	0.867	H (90)	-0.861

Inverse rank-ordered	
fuel	mean value of variable[a]
EM-240-F	2.7370
EM-242-F	3.3404
EM-238-F	4.0840
EM-239-F	4.3377
EM-241-F	4.6381

VW Rabbit Diesel

Inverse rank-ordered		Pairwise correlations between HC (V40) and fuel variables for indicated operating schedules					
operating schedule	mean value of variable[a]	highest	r	2nd highest	r	3rd highest	r
50 km/h	3.6000	IBP (76)	0.921	S (92)	0.907	5% (77)	0.898
Hot FTP	5.9774	N (91)	0.978	cetane[b] (61)	-0.869	C (89)	0.852
NYCC	6.8028	N (91)	0.956	C (89)	0.906	H (90)	-0.874
CFDS	6.9366	N (91)	0.921	cetane[b] (61)	-0.843	C (89)	0.717
Idle	8.2700	N (91)	0.947	C (89)	0.922	H (90)	-0.900
1975 FTP	9.1863	N (91)	0.990	C (89)	0.851	cetane[b] (61)	-0.827
FET	9.6125	flash (62)	-0.745	visc. (60)	-0.715	EP (88)	-0.706
85 km/h	10.0300	cetane (61)[b]	-0.918	N (91)	0.890	C (89)	0.667
Cold FTP	13.4020	N (91)	0.988	C (89)	0.848	cetane[b] (61)	-0.839

Inverse rank-ordered	
fuel	mean value of variable[a]
EM-242-F	5.9872
EM-238-F	6.2598
EM-240-F	6.3191
EM-239-F	6.3263
EM-241-F	16.1173

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[a] brackets surround means not significnatly different at the 0.05 level

[b] cetane index, not cetane number

TABLE 58. MULTIPLE COMPARISONS OF MEANS AND STRONGEST PAIRWISE FUEL VARIABLE CORRELATORS FOR EMISSIONS VARIABLES: CO (V41), g/h

Mercedes 240D

Inverse rank-ordered		Pairwise correlations between CO (V41) and fuel variables for indicated operating schedules					
operating schedule	mean value of variable[a]	highest	r	2nd highest	r	3rd highest	r
Idle	6.4920	C (89)	0.923	par. (95)	-0.907	H (90)	-0.903
50 km	13.4000	C (89)	0.996	H (90)	-0.981	aro. (93)	0.927
NYCC	14.8793	N (91)	0.852	cetane[b] (61)	-0.751	C (89)	0.577
Hot FTP	⌈19.1906	N (91)	0.783	20% (79)	0.542	ole. (94)	-0.489
1975 FTP	⌊19.9456⌉	20% (79)	0.765	N (91)	0.734	ole. (94)	-0.724
Cold FTP	20.7636⌋	20% (79)	0.793	N (91)	0.762	ole. (94)	-0.753
CFDS	24.8374	N (91)	0.662	IBP (76)	-0.647	flash (62)	-0.592
FET	30.5429	IBP (76)	-0.793	flash (62)	-0.753	EP (88)	-0.673
85 km/h	33.4900	IBP (76)	-0.829	S (92)	-0.545	5% (77)	-0.501

Inverse rank-ordered	
fuel	mean value of variable[a]
EM-238-F	⌈18.4520
EM-240-F	⌊19.8950⌉
EM-239-F	20.5992
EM-242-F	⌈20.8621⌋
EM-241-F	⌊22.1591

VW Rabbit Diesel

Inverse rank-ordered		Pairwise correlations between CO (V41) and fuel variables for indicated operating schedules					
operating schedule	mean value of variable[a]	highest	r	2nd highest	r	3rd highest	r
NYCC	⌈14.2714	cetane (61)[b]	-0.944	N (91)	0.932	C (89)	0.841
Idle	15.4800⌉	N (91)	0.957	C (89)	0.915	H (90)	-0.884
Hot FTP	16.4850	N (91)	0.944	cetane[b] (61)	-0.839	C (89)	0.625
1975 FTP	18.1210	N (91)	0.985	cetane[b] (61)	-0.851	C (89)	0.757
50 km/h	19.0000	N (91)	0.969	cetane[b] (61)	-0.903	C (89)	0.838
Cold FTP	⌊20.1344	N (91)	0.990	cetane[b] (61)	-0.848	C (89)	0.816
CFDS	⌈22.4879⌋	IBP (76)	-0.828	cetane[b] (61)	-0.630	S (92)	-0.597
FET	⌊29.3026⌉	S (92)	-0.944	5% (77)	-0.928	EP (88)	-0.903
85 km/h	31.1100⌋	70% (84)	-0.979	60% (83)	-0.979	50% (82)	-0.976

Inverse rank-ordered	
fuel	mean value of variable[a]
EM-238-F	⌈17.7859
EM-242-F	18.0986
EM-239-F	18.7619
EM-240-F	⌊21.0392⌉
EM-241-F	27.8655⌋

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[a] brackets surround means not significantly different at the 0.05 level

[b] cetane index, not cetane number

TABLE 59. MULTIPLE COMPARISONS OF MEANS AND STRONGEST PAIRWISE FUEL VARIABLE CORRELATORS FOR EMISSIONS VARIABLES: NO_x (V42), g/h

Mercedes 240D

Inverse rank-ordered		Pairwise correlations between NO_x (V42) and fuel variables for indicated operating schedules					
operating schedule	mean value of variable[a]	highest	r	2nd highest	r	3rd highest	r
Idle	6.2280	cetane (61)[b]	-0.927	N (91)	0.874	C (89)	0.643
NYCC	14.5898	cetane (61)[b]	-0.752	N (91)	0.737	IBP (76)	-0.640
50 km/h	⎡23.2000	dens. (59)	0.913	20% (79)	0.912	30% (80)	0.911
Hot FTP	⎢24.6646	20% (79)	0.830	ole. (94)	-0.785	N (91)	0.701
1975 FTP	⎢25.3568	20% (79)	0.810	ole. (94)	-0.778	N (91)	0.756
Cold FTP	⎣25.9230	20% (79)	0.847	ole. (94)	-0.833	10% (78)	0.812
CFDS	42.4025	aro. (93)	0.934	par. (95)	0.932	gum (96)	0.836
FET	55.6594	N (91)	0.893	C (89)	0.859	cetane[b] (61)	-0.809
85 km/h	62.7300	flash (62)	0.851	EP (88)	0.663	5% (77)	0.571

Inverse rank-ordered	
fuel	mean value of variable[a]
EM-240-F	⎡29.1847
EM-242-F	⎢30.3405⎤
EM-239-F	⎢31.4438⎥
EM-238-F	⎣31.8652⎥
EM-241-F	33.1403⎦

VW Rabbit Diesel

Inverse rank-ordered		Pairwise correlations between NO_x (V42) and fuel variables for indicated operating schedules					
operating schedule	mean value of variable[a]	highest	r	2nd highest	r	3rd highest	r
Idle	⎡5.1120	EP (88)	-0.832	5% (77)	-0.811	95% (87)	-0.804
NYCC	⎣9.9292	20% (79)	0.796	ole. (94)	-0.791	30% (80)	0.697
50 km/h	⎡16.4000	cetane (61)[b]	0.841	par. (95)	0.721	aro. (93)	-0.644
Hot FTP	⎢18.4356	ole. (94)	-0.619	cetane[b] (61)	0.587	par. (95)	0.520
1975 FTP	⎢19.0018	ole. (94)	-0.690	visc. (60)	0.616	cetane[b] (61)	0.585
Cold FTP	⎣19.3614	visc. (60)	0.752	flash (62)	0.707	par. (94)	-0.697
CFDS	29.9838	N (91)	0.674	IBP (76)	0.459	par. (94)	-0.453
FET	41.5507	ole. (94)	-0.864	visc. (60)	0.798	95% (87)	0.769
85 km/h	52.5300	40% (81)	-0.989	10% (78)	-0.986	50% (82)	-0.986

Inverse rank-ordered	
fuel	mean value of variable[a]
EM-238-F	⎡22.5090
EM-241-F	⎢22.5503
EM-239-F	⎢23.6779
Em-240-F	⎢24.5711
EM-242-F	⎣24.6137

[a] brackets surround means not significantly different at the 0.05 level

[b] cetane index, not cetane number

Regression equations calculated from the foregoing data are limited to particulate sulfur (V10) and sulfate (V11) against fuel sulfur(92). To reduce the influence of extraneous variables, the particulate sulfur and sulfate data used will be in fuel specific units for averages over all operating schedules from Appendix G, pages G-63 and G-64. The equations are as follows:

Mercedes: $\text{particulate sulfur}(10) = 4.63 + 155\ (\text{fuel sulfur},92)$, $r^2 = 0.835$

$\text{sulfate}(11) = 19.8 + 363\ (\text{fuel sulfur},92)$, $r^2 = 0.937$

Volkswagen: $\text{particulate sulfur}(10) = 4.28 + 123\ (\text{fuel sulfur},92)$, $r^2 = 0.974$

$\text{sulfate}(11) = 35.3 + 325\ (\text{fuel sulfur},92)$, $r^2 = 0.884$

Note that even though fuel sulfur(92) was highly correlated with other fuel variables, as already noted, these equations are very good predictors of average sulfur and $SO_4^=$ over the nine operating schedules.

F. Effect of Operating Schedules on Emissions Variables

Using the statistics of the operating schedules from Table 7 and averages (over five fuels and two vehicles, not including 1975 FTP or cold start FTP results) of the nine emissions variables discussed in section IX.D., multiple linear regression equations have been computed. A complete correlation matrix for all these operating schedule and emissions variables appears as Table 60. Note that among the operating schedule variables, idle time and average speed show a moderately strong negative pairwise correlation, while stops per hour and $s_v/\overline{V}$ (speed coefficient of variation) exhibit a strong positive pairwise correlation. As a result of these observations, the equations will be truncated after inclusion of the second operating schedule variable to prevent the latter highly correlated pair from causing inflated coefficients or unrealistically high r^2 values.

Regression equations for the nine emissions variables are as follows:

particulate mass (V4), g/h $= 1.16 + 0.148(\text{speed}) + 2.67(s_v/\overline{V})$; $r^2 = 0.912$

solubles (V6), % of particulate mass $= 15.6 - 0.0668(\text{speed}) - 0.0333(\%\ \text{idle})$; $r^2 = 0.797$

TABLE 60. CORRELATION MATRIX FOR OPERATING SCHEDULE VARIABLES AND NINE EMISSIONS VARIABLES, BOTH VEHICLES

Variable	Var. no.	Correlation coefficient (r) by variable or variable number											
		speed	$s_v/\overline{V}$	% idle	stops/h	4	6	10	11	12	35	40	41
$s_v/\overline{V}$	---[a]	-0.402	1.000	----[b]	----[b]	----[b]	----[b]	----[b]	----[b]	----[b]	----[b]	----[b]	----[b]
% idle time	---[a]	-0.841	0.006	1.000	----[b]	----[b]	----[b]	----[b]	----[b]	----[b]	----[b]	----[b]	----[b]
stops/hour	---[a]	-0.493	0.947	0.113	1.000	----[b]	----[b]	----[b]	----[b]	----[b]	----[b]	----[b]	----[b]
particulate mass	4	0.925	-0.155	-0.754	-0.289	1.000	----[b]	----[b]	----[b]	----[b]	----[b]	----[b]	----[b]
% solubles	6	-0.764	0.535	0.392	0.658	-0.800	1.000	----[b]	----[b]	----[b]	----[b]	----[b]	----[b]
sulfur	10	0.869	-0.229	-0.637	-0.393	0.964	-0.842	1.000	----[b]	----[b]	----[b]	----[b]	----[b]
sulfate	11	0.872	-0.237	-0.622	-0.408	0.969	-0.887	0.976	1.000	----[b]	----[b]	----[b]	----[b]
BaP	12	0.365	0.470	-0.348	0.267	0.658	-0.426	0.623	0.690	1.000	----[b]	----[b]	----[b]
(100-CHNS)%	35	-0.859	-0.002	0.969	0.079	-0.816	0.461	-0.715	-0.674	-0.374	1.000	----[b]	----[b]
HC	40	0.609	-0.222	-0.207	-0.282	0.788	-0.768	0.830	0.836	0.609	-0.340	1.000	----[b]
CO	41	0.943	-0.271	-0.711	-0.370	0.988	-0.819	0.953	0.958	0.572	-0.779	0.825	1.000
NO_x	42	0.956	-0.315	-0.722	-0.412	0.981	-0.820	0.955	0.948	0.519	-0.790	0.806	0.997

[a] uncoded

[b] redundant data omitted

$$\text{sulfur (V10), mg/h} = -36.0 + 2.49(\text{speed}) + 0.607(\%\ \text{idle}); \quad r^2 = 0.786$$

$$\text{sulfate (V11), mg/h} = -143 + 7.96(\text{speed}) + 2.19(\%\ \text{idle}); \quad r^2 = 0.803$$

$$\text{BaP (V12), }\mu\text{g/h} = 9.14 + 7.95\ (s_V/\overline{V}) + 0.0989(\text{speed}); \quad r^2 = 0.588$$

$$\text{100-CHNS (V35), \% of particulate} = 23.4 + 0.178(\%\ \text{idle}) - 0.0368(\text{speed}); \quad r^2 = 0.945$$

$$\text{HC (V40), g/h} = 1.57 + 0.0658(\text{speed}) + 0.0399(\%\ \text{idle}); \quad r^2 = 0.690$$

$$\text{CO (V41), g/h} = 6.23 + 0.296(\text{speed}) + 0.0603(\%\ \text{idle}); \quad r^2 = 0.911$$

$$\text{NO}_x\ \text{(V42), g/h} = -6.33 + 0.715(\text{speed}) + 0.144(\%\ \text{idle}); \quad r^2 = 0.936$$

While speed is the dominant variable, those emissions (BaP and 100-CHNS) which are obviously influenced by speed variation and/or idle time show speed entering second. The major weaknesses of these equations are small sample size, and inclusion of only two vehicles in the test work.

G. Effect on Ambient Variables on Particulate Emissions

At the request of the Project Officer, particulate mass emissions (variable 4) were subjected to regression analysis against atmospheric humidity, atmospheric pressure, and room (test) temperature. All the data together, as well as several data subsets, were used as separate data bases for this analysis. It should be noted that the ambient data used were not acquired for the purpose of regression analysis, and consequently the type of instrumentation used was less than optimum for both humidity and temperature.

With these comments, the regression equations are presented as Table 61, showing very low correlations between particulate mass emissions and the ambient variables. These results are essentially as expected, since the range of ambient variables encountered was not really sufficient for such use.

TABLE 61. RESULTS OF LINEAR REGRESSIONS, PARTICULATE MASS RATE AGAINST HUMIDITY, TEMPERATURE, AND ATMOSPHERIC PRESSURE

form of equations: $y = a + bx$

y = particulate mass emissions, g/km
x = hygrometer humidity (Hchart), g H_2O/kg dry air;
psychrometer humidity (Hw/d), g H_2O/kg dry air;
room temperature (Ta), °F; or
atmospheric pressure (pa), in Hg

Data Set	Observations = n	Independent Variable "x"	Coefficients		
			a	b	r^2
All Tests	161	Hchart	1.56548	-0.0859574	0.0247496
		Hw/d	0.543412	-0.00768611	0.000575875
		Ta	0.919650	-0.00600497	0.000417365
		pa	0.0213497	0.0162720	0.00256279
All Mercedes 240D Tests	73	Hchart	1.96220	-0.112828	0.0440460
		Hw/d	1.01127	-0.0428319	0.0145391
		Ta	4.43593	-0.0497336	0.0204269
		pa	-13.4955	0.479753	0.00373618
All VW Rabbit Diesel Tests	88	Hchart	0.991178	-0.0448559	0.00650675
		Hw/d	0.0752543	0.0272028	0.00892863
		Ta	0.746051	0.0149281	0.00267588
		pa	0.0708191	0.0164591	0.000437150
All Mercedes 240D Cold FTP Tests	15	Hchart	0.345852	-0.00178652	0.00223228
		Hw/d	0.334656	-0.00174411	0.00558608
		Ta	0.244506	0.000996933	0.00202044
		pa	4.87646	-0.156209	0.0878518
All VW Rabbit Diesel Cold FTP Tests	20	Hchart	0.507134	-0.0151840	0.0137960
		Hw/d	0.397945	-0.00724932	0.00625180
		Ta	0.970408	-0.00861147	0.00791982
		pa	6.12242	-0.199414	0.00975743

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APPENDIX A

CONTRACT 68-03-2440

SCOPE OF WORK

68-03-2440 EXHIBIT "A" (2 pages)

Scope of Work April 15, 1976

The major objective of this work is to gather data concerning the exhaust emissions of light duty diesel vehicles as the vehicles are operated with various diesel fuels. In order to achieve the objectives of this work, the following tasks shall be performed:

Task I Fuel Selection

The Contractor shall test the vehicles on a total of five (5) test fuels. Four of these fuels shall be commercially available diesel fuels that are distinct from one another in chemical and physical properties, yet represent a significant share of the diesel fuel market. The specific fuels shall be selected by the Project Officer (with input from the Contractor) at the inception of the contract. Examples of candidate fuels include the following:

A. No. 1 Diesel Fuel

B. No. 2 Diesel Fuel Representative of "National Average" properties

C. A low cetane (e.g. 42), high aromatic diesel fuel

D. A high cetane (e.g. 52), high paraffin diesel fuel

The fifth fuel to be tested shall be a "synthetic" fuel that has been derived from a source such as oil shale, tar sands, coal, etc. The selection of this fuel shall be made at the inception of the contract by the Project Officer with Contractor input. "Synthetic" fuel selection criteria shall include a) availability of the fuel in quantities needed for the testing, b) likelihood of the fuel being produced and marketed in significant quantities, c) likelihood of the fuel being produced as diesel fuel,etc. Upon final selection of the test fuels, the Contractor shall acquire sufficient quantities of the fuels for all planned testing.

Task II Vehicle Acquisition

This contract involves the testing of two (2) recently developed light duty diesel engine equipped vehicles. The final vehicle selection shall be made by the Project Officer at the inception of the contract to assure the best choices that result from this flexibility. The vehicles being considered are the following:

A. A small diesel, such as the Volkswagen. EPA currently has a Volkswagen diesel which can and will be tested if this appears to be the best choice at the inception of the contract.

B. A larger diesel. The Oldsmobile diesel that is being developed may be selected as the second vehicle if one is available. Project Officer may be able to help the Contractor acquire one for testing in this contract. If the Oldsmobile diesel is not available another vehicle which is comparable in size shall be selected.

The main responsibility for vehicle acquisition shall be with the Government. However, the Contractor shall assist in this endeavor whenever it is appropriate to do so.

Task III Set-up of Sampling and Analysis Procedures

Sampling and analysis shall be performed for the following compounds:

1) Particulate - The Contractor shall use techniques previously developed under contracts such as Contract No. 68-03-1230 to collect and quantify the particulate matter emitted by the vehicles. This shall include gross particulate rate, size distribution and analyses for sulfate, total sulfur, carbon, hydrogen, nitrogen, and organic extractable substances.

2) Gaseous emissions - Federal certification tests shall be performed for CO, CO_2, HC and NO_x. In addition, analyses shall be performed for aldehydes and specific hydrocarbons as per the analyses performed in Contract 68-02-1777. Also odor analyses as per EPA Contract EHSD-71-18 and/or the odor panel will be performed.

3) Detailed particulates - The Contractor shall employ high volume sampling techniques such as those employed in Contract No. 68-02-1777 to collect sufficient sample to enable analysis for benzo(α)pyrene, phenols, molecular weight range of paraffinic hydrocarbons, and individual organic species.

4) smoke emissions - (see below*)

The Contractor shall set up the instrumentation and equipment necessary to carry out the above analyses. The methodologies employed and the accuracies attained shall be subject to Project Officer approval.

Task IV Vehicle Testing

The vehicles shall not be tested unless the entire vehicle has accumulated no less than 2,500 km. If the vehicle is received by the Contractor with less than 2,500 km, the Contractor shall accumulate the required kilometerage with the AMA accumulation cycle. Prior to testing, the vehicle shall be preconditioned with 500 km of modified AMA. The vehicles shall then be tested using the Federal Test Procedures (FTP), the Congested Freeway Driving Cycle (SET), the Fuel Economy Test, the "New York City" low speed driving cycle, and selected steady state cruise modes. During these cycles, the compounds listed in Task III shall be sampled and analyzed. Fuel economy shall be reported in both miles per gallon and km/kg of fuel consumed.

Task V Data Handling

The data that results from the work shall be reduced and reported in the final report. In addition to this, a limited amount of effort shall be expended comparing this data to that obtained from the long haul and mid range heavy duty diesel engines.

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* Smoke tests shall be performed during 1975 FTP tests. These FTP's shall be run separately from gaseous emission testing so that the PHS smokemeter can be installed at the vehicle tailpipe.

APPENDIX B

COMMUNICATION ON FUELS FROM W. T. TIERNEY OF TEXACO

TEXACO

PETROLEUM PRODUCTS

AUTOMOTIVE ENGINE
DEVELOPMENTS

WILLIAM T. TIERNEY
PROJECT MANAGER

TEXACO INC.
P. O. BOX 509
BEACON, NEW YORK 12508
TEL. (AREA 914) 831-3400

November 16, 1976

Mr. Karl J. Springer
Southwest Research Institute
P. O. Drawer 28510
San Antonio, Texas 78284

Dear Karl:

As mentioned in our telephone conversation, I am providing the broad boiling range fuel characteristics that were supplied by the computer printout when the broad boiling range fuel case was simulated. You will note that the distillation range is well within the 100-650 min/max distillation specification that was established for the run. As I mentioned to you, two other stipulations were a sulfur content maximum of 0.1% with an RVP of 12.0. When you plot the data of the distillation tabulated on the attachment, you will find that it falls on a straight line with the exception of the upper range. This apparently is a result of the manner in which the individual process units were manipulated by the RPMS program in providing a high yield when severity of the units was not necessary to meet the more stringent gasoline specifications of octane. I have also tabulated the percent of each of the major refinery product components contained in the blend represented by the distillation curve as well as the hydrocarbon analysis of the fuel. If you have any questions on this information, don't hesitate to contact me.

Concerning my discussion with you over the years we have regularly utilized a broad boiling range fuel in our engine and vehicle test work and have had no mechanical problems that could be associated with the fuel. It is to my knowledge that we have never had an injection system failure since the lubricity of the wide boiling range fuel is apparently more than adequate to supply the requirements of a broad range of both rotary and jerk pump systems. In line with your desire to blend up a fuel you can see that this can be done by blending an unleaded gasoline with a typical No. 2 diesel fuel with perhaps some additional Avjet in order to provide the heavier ends in suitable proportion.

This is recycled paper

You may wish to test a broader boiling range fuel than that which resulted from our refinery program since, as you know, our refinery unit allocation was based on the average of the Bureau of Mines statistics for the industry as of 1972.

I would like to take this opportunity to thank you for your courtesy for the very pleasant visit to San Antonio on November 4 and in particular for the river tour on the 3rd.

Very truly yours,

Bill

W. T. TIERNEY

WTT-khc

Attachment

BROAD BOILING RANGE FUEL CHARACTERISTICS

TBP DISTILLATION

% Distilled	Temperature °F
IBP	
36.9	160
48.1	210
54.5	230
80.4	330
84.2	360
89.5	400
EP	

COMPONENTS	
Butylenes	0.5%
90 RON Reformate	23
F.C. Cat. Gasoline	22.4
C_3 - Alkylate	1.1
C_4 - Alkylate	4.9
C 56 - Hydrocrackate	5.0
85 - 145 St. Run	6.8
C_5 mix	0.1
200 - 330 St. Run	2.1
Natural Gasoline	12
NC_4	7.1
Cat. Ck LC60	9.6
330 - 440 St. Run	5.3

Aromatics	22.5 %
Paraffin	53.3
Olefin	14.4
Naphtha	12.8

Specific Gravity	0.745
RVP	10.4

APPENDIX C

SAMPLE ANALYTICAL PROCEDURES

ALDEHYDE PROCEDURE

The procedure in use presently for characterizing gas phase aldehydes in exhaust uses a 2,4 dinitrophenylhydrazine (DNPH) method. The exhaust sample is bubbled through a mixture of DNPH in dilute hydrochloric acid. The lower molecular weight aldehydes present react to form their respective aldehyde phenylhydrazones. These phenylhydrazones are insoluble or only slightly soluble in the DNPH/HCL mixture and can be removed by a filtration step followed by a pentane washing step. The filtered precipitate and the pentane washings are combined and then the pentane is evaporated in a vacuum oven. The remaining extract contains the aldehyde phenylhydrazones.

The analysis of this extract uses a chromatographic technique. The extract is dissolved in a quantitative volume of spectro grade benzene containing an anthracene internal standard. A small sample of this dissolved extract is injected into a gas/liquid chromatograph and analyzed using a flame ionization detector and a strip chart recorder. The resulting trace or chromatogram quantitatively characterizes the individual aldehydes. From this characterization and the measured exhaust volume sampled, the composition and relative amounts of aldehydes present can be calculated.

The collection efficiency of the method has been tested by bubbling volumes of air containing a known amount of aldehydes present through the system and then extracting it and running it through analysis. The resulting data showed an efficiency of better than 98 percent.

METHOD FOR DETERMINATION OF PHENOLS IN IMPINGER SAMPLES

1. Transfer contents of sample bottle to 125 ml separatory funnel.
2. Add 13 gm NaCl to funnel and shake to dissolve.
3. Rinse condenser tube with 10 ml benzene and collect in 50 ml beaker.
4. Transfer benzene to separatory funnel containing distillate and shake vigorously for 1 minute.
5. Drain aqueous phase into another 125 ml separatory funnel. Discard benzene.
6. Add 10 ml hexane to separatory funnel and shake well.
7. Drain aqueous phase into 100 ml volumetric flask. Discard hexane.
8. Add 1 drop Phenolphthalein Indicator Solution to aqueous phase.
9. Add concentrated H_3PO_4 to aqueous phase to indicator end-point then add 2-3 drops excess H_3PO_4.
10. Cool to room temperature and add 0.5 ml diisopropyl ether (DIE).
11. Shake vigorously for 1 minute and immediately pour into 50 ml volumetric flask using appropriate funnel.
12. Swirl contents of stoppered flask and then allow DIE to collect on aqueous surface in neck of flask.
13. Insert ground glass stopper, to which has been attached a short length (60 mm) of 2 mm I.D. capillary tubing, into mating glass joint on flask.
14. Using a syringe and needle, inject water into flask through previously inserted silicone plug in flask body, so as to force the DIE up into the capillary tube.
15. Using a micro syringe, withdraw 5 µl of DIE and inject into gas chromatograph.

Column: 1.8 m (length) x 4.0 mm (ID) glass

Packing: 10% SP-2100 (a methyl silicone fluid) on 100/120 mesh Supelcoport

Column temperature: 120°C

Detector: FID

Detector temperature: 150°C

Injector temperature: 150°C

NEW BENZ α PYRENE ANALYTICAL METHOD

(Copy of report reference 10)

I. Equipment and Apparatus

  A. Fluorescence Spectrophotometer (Perkin-Elmer Model MFP-3) with the Thin Layer Plate Scanning Attachment

  B. Digital Integrator (Perkin-Elmer Model 048)

  C. Recorder (Hitachi Model QPD-33)

  D. Kuderna Danish Concentrator, 10 ml concentrator tube with 250 ml flask

  E. Thin Layer Chromatography (TLC) Plates, Analtech 8" x 8" (250 μ) 20% acetylated cellulose.

  F. Plate Scoring Apparatus, Schoffel

  G. AIS TLC plate multispotter with 100 μl teflon coated blunt syringes

  H. Soxhlet Extraction Apparatus, $ 35 x 45.

  I. Soxhlet Extraction Thimbles, Whatman Cellulose (33 x 94)

  J. Filter, Kodak Yellow Chrome II

  K. Hot Plate

II. Chemicals

  A. Cyclohexane, triple glass distilled, source: Burdick & Jackson

  B. Benzene, Spectroquality, source: Fisher Scientific

  C. Benzene, ACS grade, source: Fisher Scientific

  D. Ethanol, Spectroquality, source: Fisher Scientific

  E. Methylene Chloride, Spectroquality, source: Fisher Scientific

  F. Benzo-α-Pyrene - Recrystalized three times, source: Dr. Eugene Sawiki in EPA, ESRL/RTP.

III. Calibration

Calibration standards of Benzo-α-Pyrene are prepared in the following concentration sets.

50 ng BaP/50 μl cyclohexane
25 ng BaP/50 μl cyclohexane
20 ng BaP/50 μl cyclohexane
15 ng BaP/50 μl cyclohexane
10 ng BaP/50 μl cyclohexane
5 ng BaP/50 μl cyclohexane
1 ng BaP/50 μl cyclohexane

Prepare a large enough batch to make several sets and freeze. Use either one fresh set or one thawed set daily. After one day's use, discard.

IV. Procedure

Note: For routinizing purposes we perform the analysis over a three-day period.

A. Day No. 1

A-1. Quarterly Composites of 1" x 8" glass fiber filter strips from an NASN site are received by the laboratory. [Five (5) to eight (8) strips constitute a valid quarterly composite.]

A-2. Samples are coded and logged into a laboratory notebook with all pertinent information, i.e., air volumes, site ID, year and quarter, number of strips, date received, etc.

A-3. Filter strips are rolled into units containing no more than three strips per unit. Up to three units may be stacked in one soxhlet extraction thimble.

Note: The thimbles are prewashed prior to use by refluxing for one hour in spectroquality benzene.

A-4. The composite strips are refluxed for six hours in 100 milliliters of cyclohexane.

A-5. Allow the soxhlet to cool, remove the extract and keep it in the dark or under yellow light until used during the second day.

B. Day No. 2

B-1. Place extracts in Kuderna Danish Concentrators which are in a water bath maintained at 50°C. Blow extract down to 7 ml under a stream of dry nitrogen filtered through a molecular sieve (5A) trap.

B-2. Wash the sides of the concentrators with 10 ml fresh cyclohexane. Reconcentrate to 7 ml. The volumes are carefully brought to 10 ml with cyclohexane and the samples are transferred to 15 ml Teflon capped glass vials and stored in the dark and under 34°F refrigeration until used during the third day.

C. Day No. 3

C-1. Samples and calibration standards are removed from the refrigerator and freezer and allowed to warm to room temperature.

C-2. Using an AIS multispotter 50 µl of the samples, standards, blanks and spiked blanks are spotted on a TLC plate in 18 one cm channels scored by a Schoffel plate scoring device. Spotting time is approximately thirty (30) minutes.

Syringes (100 µl) with teflon blunt tips are loaded to the 90 µl mark and the plunger moved to the 80 µl mark. The 50 µl sample is measured from 80 µl to the 30 µl mark and the plate is removed from the spotter.

C-3. Plates are developed in TLC tanks to the 19 cm line in a solvent mixture of 100 ml ethanol and 50 ml methylene chloride. The plates are removed and allowed to air dry prior to scanning.

C-4. The plates are scanned using a Perkin-Elmer MPF-3 fluorescence spectrophotometer for benzo-α-pyrene using an excitation wavelength of 388 nm and read at an emission wavelength of 430 nm. The plates are then scanned at 434 nm ex and 470 nm em for anthanthrene.

C-5. The results are presented in both strip chart recordings and digital integrator readings.

Note: Recovery studies based on spiked blanks show an average recovery of 98.9 ± 5%.

All work is carried out under Kodak yellow chrome light.

Limit of detection based on the standard of a peak being 2 x the background noise is 0.1 ng.

V. Calculation

Where:

S = concentration of standard in nanograms
C = sample integrator counds
Cs = standard integrator counts
200 = spotting fraction, 50 µl spot from a 10 ml sample or 1/200

n = number of strips used per 10 ml sample
7 = total active area, in^2, of one strip
63 = total active area, in^2, of a whole filter
F = air flow through filter, m^3

$$\frac{(S)(C)(200)}{Cs} = \text{nanograms BaP/n}$$

$$\frac{(S)(C)(0.2)}{Cs} = \text{micrograms BaP/n}$$

$$\frac{(S)(C)(0.2)(63)}{(Cs)(n)(7)} = \text{micrograms BaP/filter}$$

$$\frac{(S)(C)(1.8)}{(Cs)(n)} = \text{micrograms BaP/filter}$$

$$1000 \times \frac{\mu g\ \text{BaP/filter}}{F} = \text{nanograms BaP/}m^3$$

APPENDIX D

TIME-SPEED TABULATIONS OF CYCLIC SCHEDULES USED FOR THIS PROJECT IN SECONDS AND km/h (FTP, CFDS, FET, AND NYCC)

LA-4 CITY CYCLE (FTP)

TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPFED KM/HR	TIME SEC	SPFED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR
0	0.0	50	36.4	100	48.8	150	0.0	200	67.7	250	89.8	300	79.0	350	17.5	400	0.0
1	0.0	51	34.3	101	49.4	151	0.0	201	70.0	251	88.7	301	78.2	351	22.8	401	0.0
2	0.0	52	30.6	102	49.7	152	0.0	202	72.6	252	87.9	302	77.4	352	27.8	402	0.0
3	0.0	53	27.5	103	49.9	153	0.0	203	74.0	253	87.2	303	75.9	353	32.2	403	4.2
4	0.0	54	25.4	104	49.7	154	0.0	204	75.3	254	86.9	304	74.2	354	36.2	404	9.5
5	0.0	55	25.4	105	48.9	155	0.0	205	76.4	255	86.4	305	72.4	355	38.1	405	14.8
6	0.0	56	28.5	106	47.9	156	0.0	206	76.4	256	86.2	306	70.5	356	40.5	406	20.1
7	0.0	57	31.9	107	48.1	157	0.0	207	76.1	257	86.7	307	68.5	357	42.8	407	25.4
8	0.0	58	34.8	108	48.6	158	0.0	208	75.9	258	86.9	308	66.8	358	45.2	408	30.7
9	0.0	59	37.3	109	49.4	159	0.0	209	75.6	259	87.0	309	64.8	359	48.3	409	36.0
10	0.0	60	38.9	110	50.2	160	0.0	210	75.6	260	87.0	310	61.9	360	49.6	410	40.2
11	0.0	61	39.6	111	51.2	161	0.0	211	75.6	261	86.6	311	59.5	361	50.8	411	41.2
12	0.0	62	40.1	112	51.8	162	0.0	212	75.6	262	85.9	312	56.6	362	51.6	412	44.2
13	0.0	63	40.2	113	52.1	163	0.0	213	75.6	263	85.3	313	54.4	363	52.8	413	46.7
14	0.0	64	39.6	114	51.8	164	5.3	214	75.9	264	84.6	314	52.3	364	54.1	414	48.3
15	0.0	65	39.4	115	51.0	165	10.6	215	76.3	265	83.8	315	50.7	365	55.5	415	48.4
16	0.0	66	39.7	116	46.0	166	15.9	216	77.1	266	84.3	316	49.2	366	55.7	416	48.3
17	0.0	67	39.9	117	40.7	167	21.2	217	78.0	267	83.7	317	49.1	367	56.2	417	47.8
18	0.0	68	39.7	118	35.4	168	26.5	218	79.0	268	83.5	318	48.3	368	56.0	418	47.1
19	0.0	69	39.6	119	30.1	169	31.9	219	79.6	269	83.2	319	46.7	369	55.5	419	46.3
20	0.0	70	39.6	120	24.8	170	35.7	220	80.4	270	82.9	320	44.2	370	55.8	420	45.1
21	4.8	71	40.4	121	19.5	171	39.1	221	81.4	271	83.0	321	39.9	371	57.1	421	40.2
22	9.5	72	41.2	122	14.2	172	41.5	222	82.1	272	83.3	322	34.6	372	57.9	422	34.9
23	13.8	73	41.4	123	8.8	173	42.5	223	82.9	273	83.8	323	32.3	373	57.9	423	29.6
24	18.5	74	40.9	124	3.5	174	41.4	224	84.0	274	84.5	324	30.7	374	57.9	424	24.3
25	23.0	75	40.1	125	0.0	175	40.4	225	85.6	275	85.3	325	29.8	375	57.9	425	19.0
26	27.2	76	40.2	126	0.0	176	39.7	226	87.0	276	86.1	326	27.4	376	57.9	426	13.7
27	27.8	77	40.9	127	0.0	177	40.2	227	87.9	277	86.9	327	24.9	377	57.9	427	8.4
28	29.1	78	41.8	128	0.0	178	40.5	228	88.3	278	88.3	328	20.1	378	58.1	428	3.1
29	33.3	79	41.8	129	0.0	179	40.9	229	88.5	279	89.1	329	17.4	379	58.6	429	0.0
30	34.9	80	41.4	130	0.0	180	41.5	230	88.3	280	89.5	330	12.9	380	58.7	430	0.0
31	36.0	81	42.0	131	0.0	181	43.8	231	87.9	281	90.1	331	7.6	381	58.6	431	0.0
32	36.2	82	43.0	132	0.0	182	42.6	232	87.9	282	90.1	332	2.3	382	57.9	432	0.0
33	35.6	83	44.2	133	0.0	183	38.6	233	88.2	283	89.8	333	0.0	383	56.5	433	0.0
34	34.6	84	46.0	134	0.0	184	36.5	234	88.7	284	88.8	334	0.0	384	54.9	434	0.0
35	33.6	85	47.1	135	0.0	185	31.2	235	89.3	285	87.7	335	0.0	385	53.9	435	0.0
36	32.8	86	47.9	136	0.0	186	28.5	236	89.6	286	86.2	336	0.0	386	50.5	436	0.0
37	31.9	87	48.4	137	0.0	187	27.7	237	90.3	287	84.5	337	0.0	387	46.7	437	0.0
38	27.4	88	48.9	138	0.0	188	29.1	238	90.6	288	82.9	338	0.0	388	41.4	438	0.0
39	24.0	89	49.4	139	0.0	189	29.9	239	91.1	289	82.9	339	0.0	389	37.0	439	0.0
40	24.0	90	49.4	140	0.0	190	32.2	240	91.2	290	82.9	340	0.0	390	32.7	440	0.0
41	24.5	91	49.1	141	0.0	191	35.7	241	91.2	291	82.2	341	0.0	391	28.2	441	0.0
42	24.9	92	48.9	142	0.0	192	39.4	242	90.9	292	80.6	342	0.0	392	23.3	442	0.0
43	25.7	93	48.8	143	0.0	193	43.9	243	90.9	293	80.4	343	0.0	393	19.3	443	0.0
44	27.5	94	48.9	144	0.0	194	49.1	244	90.9	294	80.6	344	0.0	394	14.0	444	0.0
45	30.7	95	49.6	145	0.0	195	53.9	245	90.9	295	80.4	345	0.0	395	8.7	445	0.0
46	33.9	96	48.9	146	0.0	196	58.2	246	90.9	296	79.8	346	0.0	396	3.4	446	0.0
47	36.5	97	48.1	147	0.0	197	60.0	247	90.9	297	79.6	347	1.6	397	0.0	447	0.0
48	36.9	98	47.5	148	0.0	198	63.2	248	90.7	298	79.6	348	6.9	398	0.0	448	5.3
49	36.5	99	47.9	149	0.0	199	65.2	249	90.3	299	79.6	349	12.2	399	0.0	449	10.6

LA-4 CITY CYCLE (FTP)

TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR
450	15.9	500	21.2	550	10.6	600	34.8	650	20.1	700	21.7	750	45.1	800	45.1	850	41.8
451	21.2	501	16.6	551	5.3	601	35.4	651	22.5	701	23.5	751	44.2	801	45.9	851	42.8
452	26.5	502	11.6	552	0.0	602	36.0	652	24.6	702	26.4	752	43.1	802	48.3	852	42.8
453	31.9	503	6.4	553	0.0	603	36.2	653	28.2	703	26.9	753	41.0	803	49.9	853	43.1
454	37.2	504	1.6	554	0.0	604	36.2	654	31.5	704	26.5	754	37.8	804	51.5	854	43.4
455	42.5	505	0.0	555	0.0	605	36.2	655	33.8	705	26.5	755	34.6	805	53.1	855	43.8
456	44.7	506	0.0	556	0.0	606	36.5	656	35.7	706	29.3	756	30.6	806	53.1	856	44.7
457	46.8	507	0.0	557	0.0	607	38.1	657	37.5	707	30.9	757	26.5	807	54.1	857	45.2
458	50.7	508	0.0	558	0.0	608	40.4	658	39.4	708	32.3	758	24.0	808	54.7	858	46.3
459	53.1	509	0.0	559	0.0	609	41.8	659	40.7	709	34.6	759	20.1	809	55.2	859	46.5
460	54.1	510	0.0	560	0.0	610	42.6	660	41.2	710	36.2	760	15.1	810	55.0	860	46.7
461	56.0	511	1.9	561	0.0	611	43.4	661	41.8	711	36.2	761	10.0	811	54.7	861	46.8
462	56.5	512	5.6	562	0.0	612	42.0	662	42.0	712	35.6	762	4.8	812	54.7	862	46.7
463	57.3	513	8.8	563	0.0	613	36.7	663	42.2	713	36.5	763	2.4	813	54.5	863	45.2
464	58.1	514	10.5	564	0.0	614	31.4	664	42.2	714	37.5	764	2.4	814	54.1	864	44.2
465	57.9	515	13.7	565	0.0	615	26.1	665	42.5	715	37.8	765	0.8	815	53.3	865	43.4
466	58.1	516	15.4	566	0.0	616	20.8	666	42.6	716	36.2	766	0.0	816	53.1	866	41.5
467	58.7	517	16.9	567	0.0	617	15.4	667	42.6	717	34.8	767	4.8	817	52.3	867	40.2
468	57.9	518	19.1	568	0.0	618	10.1	668	41.8	718	33.0	768	10.1	818	51.5	868	39.4
469	57.4	519	22.5	569	5.3	619	4.8	669	41.0	719	29.0	769	15.4	819	51.3	869	39.9
470	57.9	520	25.7	570	10.6	620	0.0	670	38.0	720	24.1	770	20.8	820	50.8	870	40.4
471	57.9	521	28.5	571	15.9	621	0.0	671	34.4	721	19.3	771	25.4	821	50.7	871	41.0
472	57.3	522	30.6	572	20.9	622	0.0	672	29.8	722	14.5	772	28.2	822	49.2	872	41.4
473	57.1	523	32.3	573	23.5	623	0.0	673	26.4	723	10.0	773	29.6	823	48.3	873	42.2
474	57.0	524	33.8	574	25.7	624	0.0	674	23.3	724	7.2	774	31.4	824	48.1	874	43.3
475	56.6	525	35.4	575	27.4	625	0.0	675	18.7	725	4.8	775	33.3	825	48.1	875	44.2
476	56.6	526	37.0	576	27.4	626	0.0	676	14.0	726	3.4	776	35.4	826	48.1	876	44.7
477	56.6	527	38.3	577	27.4	627	0.0	677	9.3	727	0.8	777	37.3	827	48.1	877	45.7
478	56.6	528	39.4	578	28.2	628	0.0	678	5.6	728	0.8	778	40.2	828	47.6	878	46.7
479	56.6	529	40.1	579	28.5	629	0.0	679	3.2	729	5.1	779	42.6	829	47.5	879	47.0
480	56.6	530	40.2	580	28.5	630	0.0	680	0.0	730	10.5	780	44.2	830	47.5	880	46.8
481	56.3	531	40.2	581	28.2	631	0.0	681	0.0	731	15.4	781	45.1	831	47.1	881	46.7
482	56.5	532	40.2	582	27.4	632	0.0	682	0.0	732	20.1	782	45.5	832	46.5	882	46.5
483	56.6	533	40.2	583	27.2	633	0.0	683	0.0	733	22.5	783	46.5	833	45.4	883	45.9
484	57.1	534	40.2	584	26.7	634	0.0	684	0.0	734	25.7	784	46.5	834	44.6	884	45.2
485	56.6	535	40.2	585	27.4	635	0.0	685	0.0	735	29.0	785	46.5	835	43.4	885	45.1
486	56.3	536	41.2	586	27.5	636	0.0	686	0.0	736	31.5	786	46.3	836	41.0	886	45.1
487	56.3	537	41.5	587	27.4	637	0.0	687	0.0	737	34.6	787	45.9	837	38.1	887	44.4
488	56.3	538	41.8	588	26.7	638	0.0	688	0.0	738	37.2	788	45.5	838	35.4	888	43.8
489	56.0	539	41.2	589	26.5	639	0.0	689	0.0	739	39.4	789	45.5	839	33.0	889	42.8
490	55.7	540	40.5	590	26.5	640	0.0	690	0.0	740	41.0	790	45.5	840	30.9	890	43.4
491	55.5	541	40.2	591	26.7	641	0.0	691	0.0	741	42.6	791	45.4	841	30.9	891	44.2
492	53.9	542	40.2	592	27.4	642	0.0	692	0.0	742	43.6	792	44.4	842	32.3	892	44.7
493	51.5	543	40.2	593	28.3	643	0.0	693	0.0	743	44.4	793	44.2	843	33.6	893	45.1
494	48.4	544	39.3	594	29.8	644	0.0	694	2.3	744	44.9	794	44.2	844	34.4	894	44.7
495	45.1	545	37.2	595	30.9	645	0.0	695	5.3	745	45.5	795	44.2	845	35.4	895	45.1
496	41.0	546	31.9	596	32.5	646	3.2	696	7.1	746	46.0	796	44.2	846	36.4	896	45.1
497	36.2	547	26.5	597	33.8	647	7.2	697	10.5	747	46.0	797	44.2	847	37.3	897	45.1
498	31.9	548	21.2	598	33.9	648	12.6	698	14.8	748	45.5	798	44.2	848	38.6	898	44.6
499	26.5	549	15.9	599	34.1	649	16.4	699	18.2	749	45.4	799	44.4	849	40.2	899	44.1

LA-4 CITY CYCLE (FTP)

TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SFC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SFC	SPEED KM/HR
900	43.3	950	32.3	1000	37.8	1050	0.0	1100	0.0	1150	11.9	1200	10.5	1250	0.0	1300	45.1
901	42.8	951	27.2	1001	38.6	1051	0.0	1101	0.2	1151	6.6	1201	15.8	1251	0.0	1301	46.7
902	42.6	952	21.9	1002	39.6	1052	0.0	1102	1.0	1152	1.3	1202	19.3	1252	1.6	1302	46.8
903	42.6	953	16.6	1003	39.9	1053	1.9	1103	2.6	1153	0.0	1203	20.8	1253	1.6	1303	46.7
904	42.6	954	11.3	1004	40.4	1054	6.4	1104	5.8	1154	0.0	1204	20.9	1254	1.6	1304	45.1
905	42.3	955	6.0	1005	41.0	1055	11.7	1105	11.1	1155	0.0	1205	20.3	1255	1.6	1305	39.7
906	42.2	956	0.6	1006	41.2	1056	17.1	1106	16.1	1156	0.0	1206	20.6	1256	1.6	1306	34.4
907	42.2	957	0.0	1007	41.0	1057	22.4	1107	20.6	1157	0.0	1207	21.1	1257	2.6	1307	29.1
908	41.7	958	0.0	1008	40.2	1058	27.4	1108	22.5	1158	0.0	1208	21.1	1258	4.8	1308	23.8
909	41.2	959	0.0	1009	38.8	1059	29.8	1109	23.3	1159	0.0	1209	22.5	1259	6.4	1309	18.5
910	41.7	960	3.2	1010	38.1	1060	32.2	1110	25.7	1160	0.0	1210	24.9	1260	8.0	1310	13.2
911	41.7	961	8.5	1011	37.3	1061	35.1	1111	29.1	1161	0.0	1211	27.4	1261	10.1	1311	7.9
912	41.5	962	13.8	1012	36.8	1062	37.0	1112	32.2	1162	0.0	1212	29.9	1262	12.9	1312	2.6
913	41.0	963	19.1	1013	36.2	1063	38.6	1113	33.8	1163	0.0	1213	31.7	1263	16.1	1313	0.0
914	39.6	964	24.5	1014	35.4	1064	39.9	1114	34.1	1164	0.0	1214	33.8	1264	16.9	1314	0.0
915	37.8	965	28.2	1015	34.8	1065	41.2	1115	34.3	1165	0.0	1215	34.6	1265	15.3	1315	0.0
916	35.7	966	29.9	1016	33.0	1066	42.6	1116	34.4	1166	0.0	1216	35.1	1266	13.7	1316	0.0
917	34.8	967	32.2	1017	28.2	1067	43.1	1117	34.9	1167	0.0	1217	35.1	1267	12.2	1317	0.0
918	34.8	968	33.9	1018	22.8	1068	44.1	1118	36.2	1168	0.0	1218	34.6	1268	14.2	1318	0.0
919	34.9	969	35.4	1019	17.5	1069	44.9	1119	37.0	1169	3.4	1219	34.1	1269	17.7	1319	0.0
920	36.4	970	37.0	1020	12.2	1070	45.5	1120	38.3	1170	8.7	1220	34.6	1270	22.5	1320	0.0
921	37.7	971	39.4	1021	6.9	1071	45.1	1121	39.4	1171	14.0	1221	35.1	1271	27.4	1321	0.0
922	38.6	972	42.3	1022	1.6	1072	44.2	1122	40.2	1172	19.3	1222	35.4	1272	31.4	1322	0.0
923	38.9	973	44.2	1023	0.0	1073	43.4	1123	40.1	1173	24.6	1223	35.2	1273	33.8	1323	0.0
924	39.3	974	45.2	1024	0.0	1074	43.4	1124	39.9	1174	29.9	1224	34.9	1274	35.1	1324	0.0
925	40.1	975	45.7	1025	0.0	1075	42.3	1125	40.2	1175	33.9	1225	34.6	1275	35.7	1325	0.0
926	40.4	976	45.9	1026	0.0	1076	39.4	1126	40.9	1176	37.0	1226	34.6	1276	37.0	1326	0.0
927	40.5	977	45.9	1027	0.0	1077	36.2	1127	41.5	1177	37.8	1227	34.4	1277	38.0	1327	0.0
928	40.7	978	45.9	1028	0.0	1078	34.6	1128	41.8	1178	37.0	1228	32.3	1278	38.8	1328	0.0
929	41.0	979	44.6	1029	0.0	1079	33.1	1129	42.5	1179	36.2	1229	31.4	1279	39.4	1329	0.0
930	40.5	980	44.2	1030	0.0	1080	29.0	1130	42.8	1180	32.2	1230	30.9	1280	39.4	1330	0.0
931	40.2	981	43.8	1031	0.0	1081	24.1	1131	43.3	1181	26.9	1231	31.5	1281	38.6	1331	0.0
932	40.2	982	43.1	1032	0.0	1082	19.8	1132	43.4	1182	21.6	1232	31.9	1282	37.8	1332	0.0
933	40.2	983	42.6	1033	0.0	1083	17.9	1133	43.4	1183	16.3	1233	32.2	1283	37.8	1333	0.0
934	39.7	984	41.8	1034	0.0	1084	17.1	1134	43.4	1184	10.9	1234	31.4	1284	37.8	1334	0.0
935	39.4	985	41.4	1035	0.0	1085	16.1	1135	43.3	1185	5.6	1235	28.2	1285	37.8	1335	0.0
936	39.1	986	40.5	1036	0.0	1086	15.3	1136	43.1	1186	0.3	1236	24.9	1286	37.8	1336	0.0
937	39.1	987	38.6	1037	0.0	1087	14.6	1137	43.1	1187	0.0	1237	20.9	1287	37.8	1337	0.0
938	39.4	988	35.4	1038	0.0	1088	14.0	1138	42.6	1188	0.0	1238	16.1	1288	38.6	1338	2.4
939	40.2	989	34.6	1039	0.0	1089	13.8	1139	42.5	1189	0.0	1239	12.9	1289	38.8	1339	7.7
940	40.2	990	34.6	1040	0.0	1090	14.2	1140	41.8	1190	0.0	1240	9.7	1290	39.4	1340	13.0
941	39.6	991	35.1	1041	0.0	1091	14.5	1141	41.0	1191	0.0	1241	6.4	1291	39.7	1341	18.3
942	39.6	992	36.2	1042	0.0	1092	14.0	1142	39.6	1192	0.0	1242	4.0	1292	40.2	1342	21.2
943	38.8	993	37.0	1043	0.0	1093	13.8	1143	37.8	1193	0.0	1243	1.1	1293	40.9	1343	24.3
944	39.4	994	36.7	1044	0.0	1094	12.9	1144	34.6	1194	0.0	1244	0.0	1294	41.2	1344	27.0
945	40.4	995	36.7	1045	0.0	1095	11.3	1145	32.2	1195	0.0	1245	0.0	1295	41.4	1345	29.4
946	41.2	996	37.0	1046	0.0	1096	8.0	1146	28.2	1196	0.0	1246	0.0	1296	41.8	1346	31.4
947	40.4	997	36.5	1047	0.0	1097	6.8	1147	25.7	1197	0.3	1247	0.0	1297	42.2	1347	32.7
948	38.6	998	36.5	1048	0.0	1098	4.2	1148	22.5	1198	2.4	1248	0.0	1298	43.4	1348	34.3
949	35.4	999	36.5	1049	0.0	1099	1.6	1149	17.2	1199	5.6	1249	0.0	1299	44.7	1349	35.2

LA-4 CITY CYCLE (FTP)

TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR
1350	35.6														
1351	36.0														
1352	35.4														
1353	34.8														
1354	33.9														
1355	33.0														
1356	32.2														
1357	31.5														
1358	29.3														
1359	29.2														
1360	26.5														
1361	24.9														
1362	22.5														
1363	17.7														
1364	12.9														
1365	8.4														
1366	4.0														
1367	0.0														
1368	0.0														
1369	0.0														
1370	0.0														
1371	0.0														

SULFATE-7 (SFT) OR CFDS

TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR
0	0.0	50	34.8	100	48.1	150	32.2	200	32.0	250	88.5	300	72.9	350	84.0	400	6.0
1	0.0	51	37.2	101	46.8	151	32.2	201	32.2	251	90.1	301	74.0	351	82.2	401	8.0
2	0.0	52	39.4	102	46.2	152	31.9	202	32.2	252	90.9	302	75.5	352	60.8	402	8.0
3	0.0	53	41.8	103	47.6	153	32.2	203	32.2	253	90.9	303	77.2	353	80.1	403	8.7
4	0.0	54	44.4	104	48.8	154	31.5	204	32.8	254	90.6	304	78.8	354	79.6	404	11.6
5	0.0	55	46.3	105	49.4	155	29.1	205	34.4	255	90.1	305	80.3	355	79.6	405	14.5
6	0.0	56	47.6	106	48.3	156	25.3	206	36.5	256	89.3	306	81.9	356	79.5	406	15.8
7	0.0	57	50.7	107	47.3	157	20.3	207	39.6	257	88.8	307	83.5	357	79.8	407	15.6
8	0.0	58	52.3	108	44.7	158	16.6	208	42.6	258	88.5	308	85.1	358	80.1	408	15.3
9	0.0	59	52.3	109	41.2	159	16.1	209	45.4	259	88.2	309	86.6	359	80.4	409	14.8
10	0.0	60	50.2	110	40.2	160	15.3	210	47.9	260	87.7	310	87.7	360	80.4	410	15.0
11	2.6	61	47.5	111	40.2	161	15.6	211	50.7	261	87.2	311	88.3	361	80.8	411	15.3
12	7.2	62	46.8	112	39.9	162	16.1	212	53.4	262	86.7	312	88.8	362	81.1	412	15.9
13	11.6	63	47.3	113	37.8	163	16.1	213	56.2	263	86.9	313	88.5	363	80.9	413	16.4
14	15.6	64	49.6	114	37.0	164	16.1	214	59.1	264	87.7	314	88.0	364	80.4	414	16.7
15	18.3	65	49.6	115	37.0	165	16.1	215	61.5	265	87.7	315	87.4	365	80.0	415	17.2
16	21.4	66	49.6	116	38.0	166	16.9	216	63.2	266	85.0	316	86.1	366	78.8	416	19.5
17	23.0	67	49.4	117	38.6	167	19.0	217	64.4	267	81.1	317	85.3	367	76.9	417	21.7
18	24.0	68	49.4	118	40.2	168	21.9	218	65.5	268	80.4	318	84.8	368	74.3	418	23.7
19	24.1	69	49.4	119	42.3	169	24.5	219	66.0	269	79.8	319	85.8	369	70.8	419	24.1
20	25.3	70	47.8	120	43.9	170	27.0	220	66.0	270	80.0	320	86.4	370	66.0	420	24.1
21	26.1	71	46.3	121	45.5	171	29.6	221	66.0	271	80.4	321	86.4	371	61.1	421	24.5
22	24.8	72	43.8	122	47.1	172	31.5	222	66.0	272	81.3	322	86.4	372	55.8	422	24.1
23	23.7	73	40.2	123	48.1	173	32.2	223	64.4	273	80.9	323	87.7	373	50.5	423	23.7
24	23.7	74	36.2	124	48.9	174	32.5	224	63.6	274	80.4	324	88.5	374	45.2	424	24.1
25	24.1	75	33.0	125	51.3	175	32.2	225	63.2	275	79.3	325	88.5	375	39.9	425	24.1
26	24.1	76	31.1	126	52.1	176	31.9	226	63.7	276	76.9	326	88.8	376	35.1	426	24.3
27	24.0	77	31.1	127	52.1	177	32.2	227	64.2	277	72.9	327	89.1	377	33.0	427	26.1
28	22.4	78	31.4	128	51.5	178	31.4	228	64.4	278	68.1	328	89.3	378	32.2	428	28.3
29	18.7	79	33.3	129	50.8	179	29.3	229	65.0	279	64.7	329	89.5	379	32.2	429	30.4
30	16.1	80	34.3	130	49.9	180	26.1	230	66.3	280	64.4	330	89.5	380	32.2	430	32.0
31	16.1	81	33.1	131	47.6	181	21.7	231	67.9	281	64.0	331	89.3	381	31.7	431	32.2
32	16.1	82	32.3	132	46.5	182	17.5	232	70.2	282	63.9	332	89.1	382	29.8	432	32.2
33	16.1	83	32.2	133	44.7	183	16.1	233	72.2	283	64.4	333	89.0	383	26.2	433	32.2
34	17.2	84	32.7	134	42.3	184	16.1	234	74.3	284	64.7	334	89.0	384	21.2	434	32.2
35	19.6	85	32.3	135	39.3	185	15.6	235	76.3	285	65.2	335	89.0	385	17.1	435	31.9
36	21.7	86	32.2	136	35.6	186	16.1	236	78.2	286	68.2	336	89.5	386	16.1	436	30.2
37	23.3	87	32.8	137	31.7	187	16.6	237	80.1	287	71.1	337	89.9	387	16.1	437	27.0
38	23.8	88	33.9	138	28.0	188	16.6	238	82.1	288	72.4	338	90.3	388	15.9	438	22.2
39	24.1	89	35.7	139	25.4	189	16.1	239	84.2	289	73.2	339	90.3	389	15.4	439	16.9
40	24.5	90	37.7	140	24.1	190	16.3	240	85.9	290	72.7	340	90.3	390	14.3	440	11.6
41	24.9	91	39.4	141	24.1	191	17.1	241	87.4	291	73.0	341	90.3	391	12.7	441	7.2
42	24.1	92	41.0	142	24.1	192	18.7	242	88.3	292	72.4	342	89.9	392	10.8	442	2.9
43	24.1	93	42.8	143	24.3	193	20.8	243	89.0	293	72.4	343	89.5	393	9.0	443	0.0
44	24.5	94	44.6	144	25.9	194	22.5	244	89.3	294	72.1	344	89.0	394	8.0	444	0.0
45	24.3	95	46.2	145	28.0	195	24.3	245	89.3	295	70.8	345	88.7	395	7.7	445	0.0
46	25.4	96	47.5	146	29.9	196	26.1	246	88.5	296	70.5	346	88.3	396	6.9	446	0.0
47	27.4	97	49.6	147	31.7	197	27.8	247	88.5	297	70.0	347	88.0	397	6.4	447	0.0
48	29.9	98	49.2	148	32.2	198	29.6	248	88.5	298	71.0	348	87.0	398	7.2	448	0.3
49	32.5	99	48.9	149	33.0	199	31.1	249	88.5	299	71.8	349	85.8	399	8.0	449	3.5

SULFATE-7 (SET) OR CFDS

TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR
450	8.0	500	15.3	550	54.5	600	15.9	650	32.3	700	64.8	750	90.1	800	90.9	850	76.1
451	12.6	501	15.1	551	52.0	601	15.0	651	32.2	701	66.0	751	90.1	801	90.4	851	72.7
452	16.4	502	14.5	552	47.9	602	12.9	652	31.9	702	68.2	752	90.1	802	90.1	852	72.4
453	19.5	503	11.4	553	43.1	603	10.1	653	31.7	703	70.5	753	90.1	803	89.3	853	72.4
454	21.7	504	8.4	554	37.8	604	8.0	654	31.7	704	72.2	754	89.3	804	88.5	854	72.4
455	23.3	505	8.0	555	32.5	605	8.0	655	32.0	705	72.6	755	88.5	805	88.5	855	72.4
456	24.5	506	8.0	556	27.4	606	8.4	656	32.0	706	73.0	756	88.5	806	88.5	856	72.4
457	24.1	507	8.0	557	22.5	607	8.7	657	32.2	707	74.2	757	88.5	807	87.7	857	72.4
458	23.8	508	8.0	558	17.7	608	8.2	658	32.5	708	75.1	758	88.5	808	88.0	858	72.4
459	23.8	509	8.0	559	15.8	609	8.0	659	32.2	709	75.8	759	88.0	809	88.5	859	72.4
460	23.8	510	8.0	560	15.4	610	9.5	660	33.5	710	75.8	760	88.2	810	89.3	860	72.4
461	23.8	511	8.0	561	15.3	611	13.0	661	35.6	711	75.6	761	88.5	811	90.1	861	72.2
462	24.1	512	8.0	562	15.3	612	16.4	662	38.6	712	74.5	762	88.5	812	90.9	862	71.6
463	24.3	513	8.0	563	15.3	613	19.8	663	42.5	713	73.4	763	88.3	813	90.1	863	70.2
464	24.5	514	7.1	564	15.3	614	23.0	664	46.2	714	72.7	764	87.7	814	89.3	864	68.1
465	24.6	515	4.8	565	15.4	615	24.6	665	49.6	715	72.2	765	86.4	815	88.5	865	65.8
466	24.6	516	1.6	566	15.9	616	25.7	666	52.9	716	72.4	766	84.6	816	88.5	866	64.4
467	26.9	517	0.0	567	16.7	617	26.7	667	56.3	717	72.6	767	82.5	817	88.5	867	64.4
468	30.2	518	0.0	568	18.3	618	26.5	668	59.7	718	73.0	768	80.9	818	88.5	868	63.9
469	33.3	519	0.0	569	20.1	619	25.7	669	63.2	719	73.7	769	80.0	819	88.5	869	63.4
470	36.4	520	0.0	570	21.7	620	25.9	670	66.8	720	75.3	770	79.6	820	88.5	870	63.2
471	39.1	521	0.0	571	23.3	621	25.4	671	69.5	721	77.4	771	79.2	821	88.5	871	62.8
472	39.4	522	0.0	572	24.5	622	24.5	672	71.4	722	79.2	772	78.7	822	88.5	872	63.6
473	39.9	523	0.0	573	25.1	623	24.0	673	72.4	723	80.9	773	78.4	823	88.5	873	63.9
474	40.2	524	0.0	574	25.4	624	24.3	674	72.9	724	82.9	774	78.0	824	88.0	874	64.4
475	40.9	525	0.0	575	24.9	625	24.3	675	73.4	725	84.6	775	78.4	825	86.9	875	63.6
476	41.8	526	0.0	576	24.9	626	24.0	676	73.7	726	86.4	776	78.5	826	85.1	876	60.7
477	42.2	527	0.0	577	24.6	627	23.3	677	73.5	727	87.9	777	78.7	827	82.9	877	56.8
478	42.0	528	0.8	578	24.9	628	21.9	678	72.6	728	88.5	778	80.4	828	80.9	878	56.3
479	41.0	529	5.3	579	24.1	629	19.8	679	71.6	729	89.1	779	80.6	829	80.4	879	56.3
480	40.5	530	10.1	580	23.0	630	17.4	680	70.8	730	89.8	780	80.9	830	80.0	880	56.3
481	40.2	531	15.1	581	18.2	631	16.1	681	70.6	731	89.9	781	80.9	831	80.4	881	56.3
482	39.1	532	20.4	582	12.9	632	16.3	682	71.0	732	90.9	782	80.4	832	82.5	882	56.3
483	36.4	533	25.7	583	8.0	633	17.1	683	71.8	733	91.7	783	80.4	833	83.2	883	56.3
484	31.5	534	31.1	584	8.0	634	17.5	684	72.4	734	91.7	784	80.8	834	83.7	884	56.3
485	26.4	535	36.4	585	8.0	635	17.4	685	72.6	735	91.7	785	80.6	835	83.7	885	56.3
486	21.1	536	41.7	586	8.0	636	15.9	686	72.4	736	91.2	786	80.8	836	83.2	886	56.0
487	16.4	537	46.7	587	8.0	637	14.8	687	72.2	737	89.8	787	81.4	837	82.7	887	55.7
488	15.6	538	51.5	588	8.2	638	15.6	688	71.3	738	88.3	788	82.4	838	82.4	888	53.1
489	15.1	539	55.5	589	9.8	639	16.1	689	69.7	739	87.2	789	83.5	839	82.1	889	48.3
490	14.5	540	57.1	590	11.9	640	16.7	690	67.4	740	86.6	790	84.5	840	81.6	890	44.2
491	14.2	541	56.8	591	13.8	641	18.2	691	65.2	741	85.8	791	85.4	841	80.9	891	40.2
492	13.7	542	56.8	592	15.6	642	20.4	692	64.0	742	85.0	792	86.6	842	80.4	892	40.2
493	13.0	543	56.8	593	16.1	643	22.5	693	63.9	743	84.8	793	87.5	843	80.8	893	40.7
494	13.5	544	56.8	594	16.4	644	24.5	694	64.4	744	85.3	794	88.2	844	81.3	894	41.0
495	14.2	545	56.6	595	16.3	645	26.5	695	64.4	745	86.9	795	88.5	845	80.9	895	40.5
496	14.6	546	56.5	596	15.9	646	28.6	696	64.4	746	88.5	796	89.3	846	80.6	896	40.1
497	14.5	547	56.3	597	15.8	647	30.6	697	64.4	747	89.8	797	89.6	847	80.4	897	39.3
498	14.3	548	56.3	598	15.8	648	31.9	698	64.4	748	89.9	798	90.1	848	80.0	898	37.2
499	14.3	549	56.0	599	15.9	649	32.5	699	64.5	749	89.9	799	90.6	849	79.2	899	34.3

SULFATE-7 (SET) OR CFDS

TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR
900	32.2	950	27.2	1000	56.2	1050	65.2	1100	89.0	1150	84.2	1200	82.7	1250	88.8	1300	79.5
901	31.7	951	30.1	1001	57.8	1051	65.5	1101	89.3	1151	85.1	1201	81.1	1251	88.5	1301	79.2
902	31.2	952	33.1	1002	59.4	1052	65.6	1102	89.0	1152	86.2	1202	80.1	1252	88.2	1302	78.8
903	31.7	953	35.9	1003	61.0	1053	65.8	1103	88.7	1153	87.4	1203	78.8	1253	87.7	1303	79.2
904	32.0	954	38.6	1004	62.4	1054	65.5	1104	88.3	1154	88.2	1204	77.7	1254	86.9	1304	79.0
905	32.2	955	41.4	1005	63.6	1055	65.2	1105	88.0	1155	88.8	1205	77.2	1255	86.4	1305	79.0
906	32.3	956	44.4	1006	65.2	1056	65.5	1106	87.7	1156	89.3	1206	77.1	1256	86.6	1306	79.0
907	33.6	957	46.7	1007	66.0	1057	65.6	1107	87.4	1157	89.6	1207	77.2	1257	86.4	1307	79.8
908	35.2	958	48.1	1008	66.6	1058	65.3	1108	87.0	1158	89.9	1208	77.7	1258	86.7	1308	80.3
909	36.8	959	48.6	1009	66.9	1059	65.6	1109	86.7	1159	90.1	1209	77.7	1259	87.4	1309	80.9
910	38.5	960	49.1	1010	66.5	1060	65.6	1110	86.4	1160	90.3	1210	77.7	1260	88.0	1310	82.2
911	39.9	961	49.6	1011	66.0	1061	65.8	1111	86.1	1161	89.9	1211	77.7	1261	88.5	1311	83.5
912	40.7	962	49.2	1012	65.5	1062	68.4	1112	85.9	1162	89.8	1212	78.4	1262	88.5	1312	64.8
913	41.2	963	49.6	1013	65.2	1063	70.8	1113	85.8	1163	89.5	1213	80.6	1263	88.0	1313	66.2
914	40.9	964	49.2	1014	65.0	1064	72.4	1114	85.6	1164	89.1	1214	80.9	1264	87.7	1314	87.5
915	40.7	965	48.9	1015	64.8	1065	72.4	1115	85.8	1165	88.8	1215	81.1	1265	88.2	1315	88.3
916	40.5	966	48.6	1016	64.7	1066	73.2	1116	85.9	1166	88.7	1216	81.1	1266	88.3	1316	88.7
917	40.2	967	48.4	1017	67.4	1067	74.0	1117	86.2	1167	88.8	1217	80.6	1267	88.5	1317	89.0
918	40.2	968	48.6	1018	70.3	1068	74.5	1118	86.6	1168	89.0	1218	80.3	1268	88.7	1318	89.6
919	40.2	969	48.8	1019	72.4	1069	75.0	1119	86.9	1169	88.8	1219	80.4	1269	88.7	1319	90.1
920	39.9	970	50.2	1020	73.2	1070	74.5	1120	87.2	1170	88.7	1220	80.4	1270	89.6	1320	90.4
921	38.5	971	52.0	1021	74.0	1071	74.0	1121	87.4	1171	88.7	1221	80.4	1271	90.6	1321	90.1
922	35.9	972	53.4	1022	74.7	1072	73.5	1122	87.4	1172	88.5	1222	80.8	1272	91.1	1322	89.3
923	33.0	973	55.2	1023	74.5	1073	73.0	1123	87.5	1173	88.5	1223	81.3	1273	91.4	1323	89.6
924	32.2	974	56.2	1024	74.2	1074	72.6	1124	87.9	1174	88.5	1224	81.9	1274	90.9	1324	89.6
925	32.2	975	56.6	1025	73.9	1075	72.2	1125	88.2	1175	88.3	1225	82.1	1275	90.3	1325	89.6
926	32.2	976	57.1	1026	73.5	1076	71.9	1126	88.3	1176	88.0	1226	81.6	1276	89.6	1326	89.6
927	32.2	977	56.6	1027	73.2	1077	71.6	1127	88.5	1177	87.7	1227	81.9	1277	89.5	1327	89.3
928	32.2	978	56.5	1028	72.9	1078	71.3	1128	88.2	1178	87.9	1228	81.7	1278	89.5	1328	89.6
929	31.7	979	56.3	1029	72.6	1079	71.6	1129	87.0	1179	87.9	1229	83.0	1279	89.5	1329	89.9
930	31.4	980	56.3	1030	72.4	1080	71.8	1130	84.6	1180	88.0	1230	84.2	1280	89.0	1330	90.4
931	31.1	981	56.0	1031	72.2	1081	72.1	1131	81.7	1181	88.2	1231	85.3	1281	88.5	1331	91.1
932	30.7	982	55.0	1032	71.4	1082	72.4	1132	80.8	1182	88.3	1232	86.4	1282	88.3	1332	91.2
933	31.1	983	53.1	1033	70.2	1083	72.4	1133	80.3	1183	88.2	1233	87.5	1283	87.9	1333	90.6
934	31.4	984	50.7	1034	68.2	1084	72.6	1134	80.6	1184	88.0	1234	88.3	1284	87.0	1334	90.1
935	31.7	985	48.6	1035	65.6	1085	73.7	1135	80.4	1185	87.9	1235	88.7	1285	85.8	1335	90.1
936	32.0	986	48.3	1036	62.4	1086	75.6	1136	80.6	1186	88.0	1236	89.1	1286	84.2	1336	89.8
937	30.7	987	47.9	1037	59.4	1087	77.9	1137	80.8	1187	88.0	1237	90.3	1287	82.4	1337	89.6
938	28.2	988	47.6	1038	57.1	1088	79.8	1138	80.9	1188	88.2	1238	90.6	1288	81.1	1338	89.3
939	25.1	989	47.9	1039	56.3	1089	81.9	1139	80.6	1189	88.0	1239	90.6	1289	80.4	1339	89.0
940	24.1	990	47.6	1040	56.3	1090	83.8	1140	80.4	1190	87.9	1240	90.3	1290	80.0	1340	88.5
941	24.1	991	47.9	1041	56.3	1091	85.9	1141	80.4	1191	88.0	1241	90.4	1291	79.6	1341	88.8
942	23.7	992	47.6	1042	56.3	1092	87.5	1142	80.4	1192	88.5	1242	90.6	1292	78.8	1342	89.0
943	23.0	993	47.3	1043	56.3	1093	88.5	1143	80.3	1193	88.5	1243	90.1	1293	77.7	1343	88.8
944	22.5	994	47.9	1044	56.3	1094	89.3	1144	80.0	1194	88.5	1244	90.1	1294	76.9	1344	88.8
945	22.8	995	48.8	1045	56.5	1095	90.1	1145	80.3	1195	88.5	1245	89.6	1295	77.2	1345	88.5
946	23.3	996	49.7	1046	58.4	1096	90.6	1146	80.4	1196	88.3	1246	88.8	1296	77.6	1346	88.2
947	23.7	997	51.2	1047	60.7	1097	90.9	1147	80.9	1197	87.7	1247	88.5	1297	77.6	1347	88.0
948	24.1	998	52.9	1048	62.9	1098	90.6	1148	81.9	1198	86.6	1248	88.5	1298	77.7	1348	87.7
949	25.1	999	54.5	1049	64.4	1099	90.1	1149	83.0	1199	84.8	1249	88.7	1299	78.4	1349	86.9

SULFATE-7 (SET) OR CFDS

TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR
1350	86.2																
1351	86.7																
1352	87.4																
1353	87.7																
1354	87.5																
1355	87.5																
1356	87.5																
1357	87.2																
1358	86.9																
1359	86.2																
1360	85.4																
1361	86.1																
1362	85.9																
1363	85.9																
1364	85.9																
1365	85.3																
1366	82.1																
1367	77.2																
1368	72.4																
1369	67.6																
1370	62.8																
1371	57.9																
1372	52.8																
1373	47.5																
1374	42.2																
1375	36.8																
1376	31.5																
1377	26.7																
1378	22.5																
1379	19.3																
1380	17.7																
1381	16.1																
1382	16.1																
1383	16.1																
1384	14.2																
1385	10.8																
1386	7.4																
1387	4.0																
1388	2.4																
1389	1.4																
1390	0.0																
1391	0.0																
1392	0.0																
1393	0.0																
1394	0.0																
1395	0.0																
1396	0.0																
1397	0.0																
1398	0.0																

HIGHWAY FUEL ECONOMY TEST (FET)

TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR
0	0.0	50	62.1	100	78.0	150	71.0	200	69.9	250	77.2	300	53.7	350	94.9	400	91.9
1	0.0	51	63.3	101	78.6	151	71.3	201	69.5	251	77.2	301	57.3	351	94.8	401	92.5
2	0.0	52	64.4	102	78.9	152	71.5	202	69.5	252	77.3	302	60.4	352	94.6	402	93.0
3	3.2	53	65.4	103	79.2	153	71.7	203	69.3	253	77.4	303	62.8	353	94.3	403	93.3
4	7.9	54	66.6	104	79.1	154	71.9	204	69.2	254	77.5	304	64.7	354	94.0	404	93.3
5	13.0	55	67.9	105	79.0	155	72.2	205	69.2	255	77.5	305	66.1	355	93.6	405	93.3
6	18.2	56	69.1	106	78.8	156	72.8	206	69.3	256	77.4	306	67.3	356	93.4	406	93.3
7	23.3	57	70.0	107	78.8	157	73.5	207	69.8	257	78.1	307	68.2	357	93.3	407	93.3
8	27.8	58	70.8	108	78.9	158	73.9	208	70.6	258	78.7	308	68.9	358	93.2	408	93.3
9	31.5	59	71.2	109	79.2	159	74.4	209	70.7	259	79.0	309	69.6	359	92.7	409	93.2
10	35.1	60	71.6	110	79.4	160	75.3	210	70.0	260	79.0	310	70.5	360	92.4	410	93.0
11	38.6	61	72.1	111	79.5	161	75.4	211	68.5	261	79.0	311	71.3	361	92.0	411	92.8
12	41.4	62	72.3	112	79.6	162	75.6	212	66.8	262	79.0	312	72.0	362	91.8	412	92.8
13	43.6	63	72.5	113	79.6	163	75.8	213	65.4	263	79.0	313	72.4	363	91.7	413	92.9
14	45.1	64	72.6	114	79.6	164	76.5	214	64.4	264	78.9	314	72.7	364	91.7	414	93.1
15	46.7	65	73.0	115	79.5	165	77.0	215	64.4	265	78.7	315	73.0	365	91.6	415	93.3
16	48.3	66	73.5	116	79.1	166	77.2	216	64.9	266	77.5	316	73.2	366	91.6	416	93.5
17	49.4	67	74.0	117	78.6	167	77.2	217	66.0	267	76.7	317	73.6	367	91.6	417	94.0
18	50.6	68	74.4	118	78.2	168	77.1	218	67.6	268	76.4	318	73.9	368	91.6	418	94.8
19	51.8	69	74.9	119	77.9	169	76.9	219	68.7	269	75.9	319	74.2	369	91.7	419	95.1
20	52.9	70	75.3	120	77.4	170	76.1	220	69.3	270	75.2	320	74.8	370	91.7	420	95.6
21	53.9	71	75.5	121	76.7	171	75.2	221	69.4	271	74.3	321	75.3	371	91.7	421	96.2
22	54.9	72	75.7	122	76.2	172	74.3	222	69.9	272	74.0	322	75.8	372	91.7	422	96.3
23	55.6	73	75.8	123	76.1	173	73.9	223	70.6	273	73.7	323	76.7	373	91.7	423	96.3
24	56.2	74	76.0	124	76.4	174	73.5	224	71.3	274	73.4	324	77.8	374	91.7	424	96.2
25	56.5	75	76.1	125	76.8	175	73.2	225	71.9	275	73.0	325	78.8	375	91.7	425	95.9
26	57.4	76	75.9	126	77.1	176	73.1	226	72.6	276	72.7	326	79.9	376	91.7	426	95.6
27	57.8	77	75.7	127	77.2	177	72.8	227	73.0	277	72.4	327	81.0	377	91.6	427	95.3
28	57.6	78	75.6	128	77.1	178	72.4	228	73.7	278	72.0	328	82.1	378	91.3	428	95.0
29	56.9	79	75.5	129	77.1	179	70.8	229	74.8	279	71.6	329	83.2	379	90.9	429	94.9
30	56.2	80	75.5	130	77.1	180	69.3	230	75.5	280	71.1	330	84.4	380	90.4	430	94.8
31	55.5	81	75.5	131	77.2	181	67.9	231	75.9	281	70.1	331	85.4	381	90.1	431	94.4
32	55.7	82	75.6	132	77.2	182	66.8	232	76.3	282	68.9	332	86.6	382	90.1	432	94.2
33	56.0	83	75.7	133	77.2	183	66.8	233	76.2	283	67.6	333	87.7	383	90.1	433	94.1
34	56.5	84	75.8	134	77.1	184	67.7	234	76.1	284	64.6	334	88.8	384	90.3	434	94.0
35	57.4	85	75.9	135	76.1	185	69.0	235	75.9	285	62.2	335	89.8	385	90.7	435	93.9
36	58.0	86	75.8	136	74.0	186	70.0	236	75.9	286	60.3	336	90.7	386	91.2	436	93.8
37	58.2	87	75.7	137	69.7	187	70.6	237	75.9	287	57.7	337	91.6	387	91.6	437	93.6
38	58.7	88	75.5	138	66.2	188	70.2	238	75.8	288	55.8	338	91.6	388	91.9	438	93.4
39	59.1	89	74.8	139	63.6	189	69.7	239	75.7	289	54.7	339	91.9	389	92.2	439	93.3
40	59.4	90	74.4	140	63.0	190	69.2	240	75.6	290	53.5	340	92.2	390	92.4	440	93.2
41	59.5	91	74.3	141	62.8	191	69.3	241	75.5	291	52.3	341	92.6	391	92.4	441	93.2
42	59.5	92	74.4	142	62.8	192	69.8	242	75.4	292	51.0	342	93.0	392	92.0	442	93.2
43	59.5	93	74.8	143	63.0	193	70.6	243	75.4	293	49.2	343	93.3	393	91.8	443	93.2
44	59.5	94	75.5	144	63.6	194	71.3	244	75.6	294	47.6	344	93.5	394	91.6	444	93.2
45	59.5	95	75.8	145	64.5	195	71.8	245	75.9	295	46.3	345	93.9	395	91.0	445	93.3
46	59.5	96	76.2	146	66.0	196	72.2	246	76.4	296	45.7	346	94.4	396	90.6	446	93.4
47	59.6	97	76.7	147	67.6	197	72.0	247	77.1	297	46.1	347	94.7	397	90.3	447	93.5
48	60.1	98	77.2	148	69.3	198	71.5	248	77.2	298	47.5	348	94.8	398	90.7	448	93.6
49	60.8	99	77.6	149	70.3	199	70.6	249	77.2	299	50.5	349	94.9	399	91.2	449	93.6

HIGHWAY FUEL ECONOMY TEST (FET)

TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR
450	93.6	500	88.1	550	89.8	600	77.7	650	80.7	700	87.2	750	43.1				
451	93.5	501	87.9	551	89.5	601	77.2	651	81.6	701	87.7	751	39.4				
452	93.4	502	87.5	552	89.1	602	77.0	652	82.2	702	88.2	752	34.6				
453	93.3	503	87.4	553	88.8	603	76.9	653	83.2	703	88.5	753	31.4				
454	93.3	504	87.3	554	88.6	604	76.7	654	83.9	704	89.3	754	27.9				
455	93.3	505	67.2	555	88.4	605	77.1	655	84.5	705	89.9	755	24.3				
456	93.3	506	87.1	556	88.3	606	77.8	656	83.8	706	90.3	756	20.0				
457	93.3	507	87.0	557	87.9	607	78.8	657	83.1	707	90.6	757	15.7				
458	93.2	508	87.0	558	87.5	608	78.9	658	82.2	708	90.8	758	11.3				
459	93.2	509	87.0	559	87.2	609	78.9	659	82.1	709	90.9	759	8.0				
460	93.3	510	86.9	560	87.0	610	78.7	660	82.1	710	91.2	760	5.4				
461	93.4	511	86.9	561	86.6	611	77.2	661	82.2	711	91.5	761	3.2				
462	93.5	512	86.9	562	85.9	612	75.7	662	82.6	712	91.7	762	1.1				
463	93.6	513	86.9	563	85.7	613	74.3	663	83.1	713	92.2	763	0.0				
464	93.7	514	86.9	564	85.4	614	74.1	664	83.7	714	92.9	764	0.0				
465	93.9	515	86.9	565	85.1	615	74.1	665	84.0	715	93.6	765	0.0				
466	93.9	516	86.9	566	84.7	616	74.3	666	84.4	716	94.6						
467	93.6	517	87.0	567	84.3	617	75.4	667	85.0	717	95.1						
468	93.4	518	87.3	568	84.0	618	76.9	668	84.9	718	95.3						
469	93.3	519	87.6	569	83.8	619	78.8	669	84.6	719	95.0						
470	93.0	520	88.2	570	83.7	620	80.0	670	84.2	720	94.7						
471	92.5	521	88.4	571	83.7	621	81.4	671	84.2	721	94.1						
472	91.9	522	88.5	572	83.7	622	82.9	672	84.2	722	93.5						
473	91.7	523	88.7	573	83.7	623	83.9	673	84.5	723	92.8						
474	91.1	524	88.8	574	83.8	624	84.7	674	84.8	724	92.2						
475	90.3	525	88.9	575	83.7	625	85.3	675	84.7	725	91.9						
476	90.2	526	89.0	576	83.6	626	86.2	676	84.3	726	91.4						
477	89.8	527	89.2	577	83.5	627	86.8	677	83.9	727	90.9						
478	89.3	528	89.3	578	83.1	628	87.0	678	83.2	728	90.4						
479	88.9	529	89.5	579	82.7	629	87.5	679	82.2	729	89.3						
480	88.6	530	89.7	580	82.2	630	88.0	680	81.3	730	87.9						
481	88.5	531	89.8	581	81.6	631	88.7	681	80.6	731	87.1						
482	88.4	532	89.9	582	80.9	632	89.2	682	80.1	732	86.4						
483	88.3	533	90.0	583	80.1	633	89.1	683	79.9	733	85.6						
484	88.3	534	90.1	584	79.3	634	88.5	684	79.8	734	85.1						
485	88.3	535	90.1	585	78.4	635	87.6	685	79.6	735	84.4						
486	88.3	536	90.1	586	77.6	636	86.3	686	79.6	736	83.7						
487	88.3	537	90.1	587	77.3	637	84.5	687	79.9	737	82.6						
488	88.4	538	90.1	588	77.2	638	80.7	688	80.4	738	81.3						
489	88.5	539	90.1	589	77.2	639	77.5	689	80.8	739	79.6						
490	88.5	540	90.1	590	77.3	640	74.8	690	81.4	740	78.0						
491	88.5	541	90.1	591	77.8	641	74.3	691	82.2	741	76.6						
492	88.5	542	90.1	592	78.7	642	74.0	692	83.0	742	75.3						
493	88.5	543	90.1	593	78.9	643	74.0	693	83.4	743	73.4						
494	88.6	544	90.1	594	79.0	644	74.5	694	83.7	744	71.1						
495	88.6	545	90.1	595	79.0	645	75.3	695	83.8	745	68.4						
496	88.5	546	90.1	596	78.9	646	76.4	696	84.2	746	63.1						
497	88.4	547	89.9	597	78.8	647	77.5	697	85.1	747	57.8						
498	88.3	548	89.9	598	78.7	648	78.6	698	85.8	748	52.5						
499	88.2	549	89.9	599	78.1	649	79.6	699	86.5	749	47.1						

NEW YORK CITY CYCLE (NYCC) OR SET-8

TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR
0	0.0	50	9.0	100	25.3	150	22.2	200	31.1	250	0.0	300	23.0	350	0.0	400	3.4
1	0.0	51	11.3	101	28.0	151	24.3	201	33.3	251	0.0	301	19.1	351	0.0	401	3.7
2	0.0	52	12.2	102	27.8	152	26.1	202	34.4	252	0.0	302	17.2	352	0.0	402	7.4
3	0.0	53	12.2	103	27.7	153	25.6	203	34.4	253	0.0	303	16.4	353	0.0	403	12.6
4	0.0	54	10.0	104	24.3	154	25.7	204	33.0	254	0.0	304	15.1	354	0.0	404	15.9
5	0.0	55	10.3	105	18.0	155	27.0	205	30.6	255	0.0	305	17.1	355	0.0	405	17.2
6	0.0	56	12.2	106	13.8	156	28.2	206	26.9	256	3.2	306	20.6	356	0.0	406	16.4
7	0.0	57	15.3	107	9.5	157	29.0	207	21.1	257	7.2	307	22.0	357	0.0	407	16.3
8	0.0	58	14.3	108	8.7	158	31.5	208	18.0	258	10.3	308	19.8	358	0.0	408	17.2
9	0.0	59	13.8	109	10.9	159	34.9	209	24.0	259	11.6	309	16.7	359	0.0	409	17.5
10	0.0	60	15.4	110	11.1	160	37.2	210	31.9	260	12.2	310	13.8	360	0.0	410	18.3
11	0.0	61	20.0	111	7.7	161	38.1	211	38.3	261	11.6	311	8.8	361	0.0	411	17.9
12	0.0	62	24.1	112	9.2	162	38.8	212	41.4	262	10.6	312	5.1	362	0.0	412	16.1
13	0.0	63	28.6	113	11.4	163	39.4	213	42.2	263	10.5	313	3.2	363	0.0	413	14.2
14	0.0	64	33.8	114	10.9	164	40.2	214	42.5	264	8.2	314	1.0	364	0.0	414	13.2
15	0.0	65	36.8	115	9.5	165	40.5	215	37.5	265	7.1	315	0.0	365	0.0	415	13.8
16	0.0	66	34.9	116	9.7	166	39.6	216	31.5	266	8.8	316	0.0	366	0.0	416	16.4
17	0.0	67	29.3	117	9.7	167	39.1	217	30.4	267	4.8	317	0.0	367	0.0	417	19.0
18	0.0	68	23.3	118	9.5	168	37.5	218	31.1	268	5.5	318	0.0	368	0.0	418	20.9
19	0.0	69	16.4	119	9.0	169	36.5	219	31.2	269	4.8	319	0.0	369	0.0	419	21.4
20	0.0	70	9.0	120	8.8	170	35.6	220	29.8	270	4.7	320	0.0	370	0.0	420	20.6
21	0.0	71	4.0	121	11.6	171	34.8	221	28.2	271	2.1	321	0.0	371	0.0	421	18.8
22	0.0	72	3.4	122	15.9	172	33.9	222	26.4	272	1.3	322	0.0	372	0.0	422	18.8
23	0.0	73	5.0	123	17.4	173	32.7	223	25.1	273	0.5	323	0.0	373	0.0	423	20.0
24	0.0	74	9.2	124	18.3	174	30.9	224	25.1	274	0.0	324	4.0	374	0.0	424	22.0
25	0.0	75	14.5	125	19.1	175	27.4	225	25.7	275	0.0	325	9.8	375	0.0	425	23.2
26	0.0	76	17.4	126	19.5	176	22.4	226	27.0	276	0.5	326	8.8	376	0.0	426	23.0
27	0.0	77	17.4	127	20.3	177	22.7	227	28.2	277	7.6	327	5.1	377	0.0	427	23.7
28	0.0	78	15.3	128	19.8	178	23.5	228	29.0	278	15.6	328	5.8	378	0.0	428	24.3
29	0.0	79	10.5	129	17.1	179	23.5	229	31.5	279	22.4	329	9.8	379	0.0	429	24.6
30	0.0	80	6.3	130	15.9	180	23.3	230	34.9	280	26.9	330	14.6	380	0.0	430	25.4
31	0.0	81	4.2	131	15.1	181	23.2	231	37.8	281	30.7	331	15.8	381	0.0	431	23.3
32	0.0	82	1.6	132	14.3	182	22.8	232	39.6	282	33.0	332	13.8	382	0.0	432	19.6
33	0.0	83	1.3	133	12.2	183	22.8	233	40.2	283	33.0	333	10.9	383	0.0	433	17.9
34	0.0	84	0.0	134	9.8	184	21.2	234	39.1	284	31.7	334	9.5	384	0.0	434	19.3
35	0.0	85	0.0	135	8.0	185	18.5	235	37.2	285	32.0	335	9.0	385	0.0	435	21.1
36	0.0	86	0.0	136	6.0	186	13.5	236	33.3	286	32.8	336	9.7	386	0.0	436	19.6
37	0.0	87	0.0	137	4.2	187	8.8	237	27.7	287	33.6	337	11.6	387	0.0	437	14.3
38	0.0	88	0.0	138	1.6	188	6.0	238	21.7	288	34.4	338	13.5	388	0.0	438	12.4
39	0.0	89	0.0	139	1.3	189	4.7	239	14.8	289	35.2	339	15.0	389	0.0	439	12.2
40	0.0	90	0.0	140	0.0	190	2.1	240	5.3	290	36.0	340	12.2	390	0.0	440	12.9
41	0.0	91	0.0	141	0.0	191	1.3	241	0.0	291	35.6	341	8.8	391	0.0	441	8.8
42	0.0	92	0.0	142	0.0	192	0.0	242	0.0	292	34.4	342	4.0	392	0.0	442	5.3
43	0.0	93	0.0	143	0.0	193	0.0	243	0.0	293	33.5	343	0.0	393	0.0	443	3.9
44	0.0	94	0.0	144	0.0	194	0.0	244	0.0	294	32.7	344	0.0	394	0.0	444	2.3
45	0.0	95	0.0	145	0.0	195	0.0	245	0.0	295	33.0	345	0.0	395	0.0	445	1.0
46	0.0	96	0.0	146	2.1	196	2.1	246	0.0	296	31.1	346	0.0	396	0.0	446	0.0
47	0.0	97	4.3	147	9.7	197	6.3	247	0.0	297	27.8	347	0.0	397	2.6	447	0.0
48	0.6	98	13.2	148	16.4	198	15.9	248	0.0	298	27.5	348	0.0	398	4.8	448	0.0
49	4.5	99	20.0	149	19.5	199	25.6	249	0.0	299	26.9	349	0.0	399	4.8	449	0.0

NEW YORK CITY CYCLE (NYCC) OR SET-8

TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR	TIME SEC	SPEED KM/HR
450	0.0	500	18.2	550	43.9	600	0.0						
451	0.0	501	19.0	551	44.6								
452	0.0	502	19.6	552	44.4								
453	0.0	503	23.0	553	43.9								
454	0.0	504	25.7	554	41.4								
455	0.0	505	28.6	555	37.5								
456	0.0	506	29.9	556	33.1								
457	0.0	507	31.5	557	28.6								
458	0.0	508	32.5	558	24.0								
459	0.0	509	32.0	559	18.2								
460	0.0	510	31.7	560	11.9								
461	0.0	511	33.5	561	7.4								
462	0.0	512	33.8	562	2.7								
463	0.0	513	30.2	563	1.1								
464	0.0	514	28.3	564	0.0								
465	0.0	515	20.9	565	0.0								
466	0.0	516	12.1	566	0.0								
467	0.0	517	4.7	567	0.0								
468	0.0	518	1.3	568	0.0								
469	0.0	519	0.0	569	0.0								
470	0.0	520	0.0	570	0.0								
471	0.0	521	1.1	571	0.0								
472	0.0	522	2.3	572	0.0								
473	0.0	523	3.7	573	0.0								
474	0.0	524	4.3	574	0.0								
475	0.0	525	4.8	575	0.0								
476	0.0	526	4.3	576	0.0								
477	0.0	527	1.9	577	0.0								
478	0.0	528	0.0	578	0.0								
479	0.0	529	1.1	579	0.0								
480	0.0	530	2.9	580	0.0								
481	0.0	531	5.0	581	0.0								
482	0.0	532	6.3	582	0.0								
483	0.0	533	8.5	583	0.0								
484	0.0	534	12.6	584	0.0								
485	0.0	535	15.6	585	0.0								
486	0.0	536	16.6	586	0.0								
487	0.0	537	16.4	587	0.0								
488	0.0	538	15.1	588	0.0								
489	0.0	539	11.4	589	0.0								
490	0.0	540	10.9	590	0.0								
491	0.0	541	14.3	591	0.0								
492	0.0	542	17.1	592	0.0								
493	0.0	543	19.1	593	0.0								
494	0.0	544	24.9	594	0.0								
495	0.0	545	31.5	595	0.0								
496	1.6	546	36.7	596	0.0								
497	6.6	547	40.4	597	0.0								
498	11.9	548	41.8	598	0.0								
499	16.4	549	43.0	599	0.0								

APPENDIX E

DATA FORMS AND DATA REDUCTION PROGRAMS

PROJECT

SwRI CVS Data Sheet

Card No.	Truck No.	Orig. Test No.	Test No.	Date			Mfg Code	Model	Vehicle I. D.	Model Year	Displ. IN³	Actual Road Load HP	No. of Cyl.	Trans. Code	Inertia Weight	Curb Weight	G. V. W.
				Mo	Day	Yr											
1												.					

2 4 5 6 12 13 14 15 16 17 18 19 21 22 25 30 35 37 38 40 45 50 53 54 55 56 59 60 63 64 65 66 70 71 75 76 80

Card No.	Ign. Time	at Speed		Gear	Idle Speed		A/C	Evap. System	Eng. Type	Comments	Date			Test No.
											Mo	Day	Yr	
0 2														

4 6 8 11 19 21 24 29 31 32 34 35 36 40 45 50 55 60 65 70 72 73 78 80

Evaporative Emissions

Card No.	1st Can			2nd Can			3rd Can				Date			Test No.
	Canister No.	Initial Weight	Final Weight	Canister No.	Initial Weight	Final Weight	Canister No.	Initial Weight	Final Weight		Mo	Day	Yr	
0 3		.	.		.	.		.	.					

3 6 7 13 14 20 21 24 25 31 32 38 39 42 43 49 50 56 73 78 80

Exhaust Emissions

Card No.	Odometer	Barometer	Air Temp °F		CVS Data			Driver	Oper.	CVS		Date			Test No.
			Dry	Wet	Temp. °F	Blower Inlet Press IN. H₂O	Diff Press. IN. H₂O				Note: CVS number is: 1 big truck CVS or 2 blue box CVS or 3 brown box CVS	Mo	Day	Yr	
0 4		.				.	.								

3 9 10 15 16 18 19 21 22 25 26 30 31 35 73 78 80

Bag 1

Background Air Sample

Card No.	HC Meter Reading	HC Range	CO Meter Reading	CO Range	CO₂ Meter Reading	CO₂ Range	NOₓ Meter Reading	NOₓ Range	Revolution Counter	Time Seconds		Date			Test No.
												Mo	Day	Yr	
0 5	.		.		.		.			.					

3 8 9 11 16 17 19 24 25 27 32 33 35 40 73 78 80

Exhaust Sample

Card No.	HC Meter Reading	HC Range	CO Meter Reading	CO Range	CO₂ Meter Reading	CO₂ Range	NOₓ Meter Reading	NOₓ Range		Date			Test No.
										Mo	Day	Yr	
0 6	.		.		.		.						

3 8 9 11 16 17 19 24 25 27 32 33 73 78 80

Bag 2

Background Air Sample

Card No.	HC Meter Reading	HC Range	CO Meter Reading	CO Range	CO₂ Meter Reading	CO₂ Range	NOₓ Meter Reading	NOₓ Range	Revolution Counter	Time Seconds		Date			Test No.
												Mo	Day	Yr	
0 7	.		.		.		.			.					

3 8 9 11 16 17 18 24 25 27 32 33 35 40 73 78 80

Card No.	HC Meter Reading	HC Range	CO Meter Reading	CO Range	CO₂ Meter Reading	CO₂ Range	NOₓ Meter Reading	NOₓ Range		Date			Test No.
										Mo	Day	Yr	
0 8	.		.		.		.						

3 8 9 11 16 17 19 24 25 27 32 33 73 78 80

Bag 3

Card No.	HC Meter Reading	HC Range	CO Meter Reading	CO Range	CO₂ Meter Reading	CO₂ Range	NOₓ Meter Reading	NOₓ Range	Revolution Counter	Time Seconds		Date			Test No.
												Mo	Day	Yr	
0 9	.		.		.		.			.					

3 8 9 11 16 17 19 24 25 27 32 33 35 40 73 78 80

Card No.	HC Meter Reading	HC Range	CO Meter Reading	CO Range	CO₂ Meter Reading	CO₂ Range	NOₓ Meter Reading	NOₓ Range		Date			Test No.
										Mo	Day	Yr	
1 0	.		.		.		.						

3 8 9 11 16 17 19 24 25 27 32 33 73 78 80

SRI

DEPT. OF EMISSIONS RESEARCH
SINGLE BAG CVS EMISSIONS DATA SHEET

Page ___ of ___

Project ____________

Vehicle No. __________ Date ____________________ Run No. __________

Remarks ____

Card No.	Vehicle No.	Test No.	Start Time	Date Mo	Date Day	Date Yr.	Mfg. Code	Manufacturer	Test Type	Model Year	Displ. IN³		Cyl. Arg.	No. of Cyl.	Trans. Code	Actual Road Hp	Test Weight	G.V.W.
0 1																		
2	4 5	6	8	12 13	14 15	16 17	18 19 21	22 23 25 30 35 37	38 40 45 50	53 54	55 56 59	60	63	64	65 66	70	71 75	76 80

Exhaust Emissions

Card No.	Odometer	Barometer	Air Temp • F Dry	Air Temp • F Wet	CVS Data Temp. • F	CVS Data Blower Inlet Press IN. H₂O	CVS Data Diff. Press IN H₂O	Driver	Oper.	Begin Fuel Wt. Lbs.	Ending Fuel W. Lbs.	Miles	Fuel H/C Ratio		Fuel Density Lb/Gal	CVS No.	SO2	SO4	Date Mo.	Date Day	Date Yr.	Test No.
0 2		.				.	.			.	.	.										
	3	9 10	15 16	18 19	21 22 25	26 30	31	35	39	42 45	47 50	52	56 57	61	62 67	68	70	71	73		78	80

Bag 1

Background Air Sample

Card No.	HC Meter Reading	HC Range	CO Meter Reading	CO Range	CO₂ Meter Reading	CO₂ Range	NOₓ Meter Reading	NOₓ Range	Revolution Counter	Time in Seconds	Dyno Roll Counts	Percent Fuel Sulfur		SO₂ Meter Reading	SO₂ Range	Date Mo.	Date Day	Date Yr	Test No.
0 3	.		.		.		.			.		.		.					
	3 8	9	11 16	17	19 24	25	27 32	33	35 40	41 47	48 53	54	60	65 70	71 72	73		78	80

Exhaust Sample

Card No.	HC Meter Reading	HC Range	CO Meter Reading	CO Range	CO₂ Meter Reading	CO₂ Range	NOₓ Meter Reading	NOₓ Range		SO₂ Meter Reading	SO₂ Range	Date Mo.	Date Day	Date Yr	Test No.
0 4	.		.		.		.								
	3 8	9	11 16	17	19 24	25	27 32	33		65 70	71 72	73		78	80

```
DTBMOL,P10,T30,I0100,LS,MFL50000.
ACCOUNT(C62280,SLICK)114654001
CID(HARRY DIETZMANN,2647)
REWIND(DISK1,DISK2)
COPYCR(INPUT,DISK1)
COPYCR(INPUT,DISK2)
REWIND(DISK1,DISK2)
COPYCR(DISK1,OUTPUT)
LIBRARY(RUN2P3)
RUN(S,,,,,,2000)
MAP(PART)
SETCORE(INDEF)
REDUCE.
LGO.
COPYCR(DISK2,OUTPUT)
*
PM      TURN PRINTER PAPER OVER
*
PM      RESTORE PRINTER PAPER
*
      PROGRAM DTBMOL(INPUT,OUTPUT,PUNCH,TAPE60=INPUT)
      INTEGER HCR(2),COR(2),CO2R(2)
      DIMENSION ITA(4),ITB(4),ITC(6),ITD(3),VMOD(2),VID(2),EIWT(3),
     1FWT(3),DIF(3),HC(2),PNO(2),CO(2),CO2(2),YH(2), YN(2),YC(2),
     2 YC2(2),HCM(3),PNOM(3),COM(3),BUF(25,3),IBUF(25,7),NOXR(2),
     3ICAN(3),N(3),CO2M(3),CHC(3),CCO(3),CCO2(3),CB(3),COMENTS(4)
      DATA ITA/10H        HC ,10H        CO ,10H       CO2,10H       NOX/,
     1     ITB/10H SAMPLE   ,10H BACKGRD ,10H CONCENTR,10H MASS GRA/,
     2     ITC/10HMETER READ,10HPPM       ,10HPERCENT   ,10HATION PPM ,
     3         10HMS        ,10HATION PCT /,ITD/10HING/SCALE ,10H
     4   ,1H /
 1001 FORMAT(1X,A3,I1,I7,3I2,I3,2(A10,A6),I2,I4,F4.1,2I1,2I5,F5.0/3X,
     1I3,1X,I4,7X,A1,1X,I4,4X,I1,1X,I2,1X,I2,3A10,A7)
 1003 FORMAT(2X,3(I4,2F7.2))
 1004 FORMAT(2X,I7,F6.2,2F3.0,I4,2F5.1,2A3,1X,I1)
 2001 FORMAT(1H1,32X,*TABLE*,19X,*VEHICLE EMISSION RESULTS*/40X, *1975
     1LIGHT DUTY EMISSIONS TEST       *)
 2111 FORMAT(/2X,*UNIT NO.  *,A3,8X,*TEST NO. *,I1,10X,*DATE *,I2,*/*,
     1I2,*/*,I2,21X,*MFGR. CODE  *,I3,17X,*YR. 19*,I2,
     2/2X,*VEHICLE MODEL  *,A10,A6,10X,*ENGINE  *,F5.2,* LITRE *,I1,
     3* CYL.*,8X,*TEST WT. *,I5,* KG*,15X,*ROAD LOAD  *,F4.1,* KW*,
     4/2X,*TEST TYPE  *,A10,A6,14X,*COMMENTS  *,3A10,A7,/)
 2002 FORMAT (2X,*BAROMETER *,F6.2,* MM OF HG.*,44X,*WET BULB TEMP *,
     1 F5.1,* DEG. C*/2X,*DRY BULB TEMP.  *,F5.1,* DEG. C*,43X, *ABS. HU
     2MIDITY *,F5.1,* MILLIGRAMS/KG*/2X,*REL. HUMIDITY   *,F4.0,* PCT.*)
 2006 FORMAT( 4A10,3(8X,F7.2,2X))
 2007 FORMAT(/7X,*WEIGHTED MASS HC   *,F7.2,* GRAMS/KILOMETRE*,
     1        /7X,*WEIGHTED MASS CO   *,F7.2,* GRAMS/KILOMETRE*,
     2        /7X,*WEIGHTED MASS CO2  *,F7.2,* GRAMS/KILOMETRE*,
     3        /7X,*WEIGHTED MASS NOX  *,F7.2,* GRAMS/KILOMETRE*)
 2009 FORMAT(2X,*EVAPORATIVE EMISSIONS*)
 2022 FORMAT                      (7X,*CANISTER*,38X,*1*,16X, *2*,16X,*3*/7X,
     1   *FINAL WT.,   GRAMS*,25X,F6.2,11X, F6.2,11X,F6.2/7X,*INITIAL WT
     2., GRAMS*,  25X,F6.2,11X,F6.2, 11X,F6.2/7X,*DIFFERENCE   GRAMS*,
     325X,F6.2,11X,F6.2,11X,F6.2//7X,*TOTAL EVAPORATIVE EMISSIONS*,43X,
     4F7.2,* GRAMS*//)
 2222 FORMAT                      (7X,*CANISTER*,38X,*1*,16X, *2*          /7X,
     1   *FINAL WT.,   GRAMS*,25X,F6.2,11X, F6.2           /7X,*INITIAL WT
     2., GRAMS*,  25X,F6.2,11X,F6.2               /7X,*DIFFERENCE   GRAMS*,
     325X,F6.2,11X,F6.2,          //7X,*TOTAL EVAPORATIVE EMISSIONS*,43X,
     4F7.2,* GRAMS*//)
 2055 FORMAT(4A10,3(10X,F5.2,2X))
```

```
2555 FORMAT(4A10,3(10X,F5.1,2X))
2999 FORMAT(1X,* WRONG CVS NUMBER*)
3000 FORMAT(1H )
5001 FORMAT(1H1,I1,I3,I1,I7,3I2,I3,2(A10,A6),I2,I4,F4.1,2I1,2I5,F5.0)
5002 FORMAT(1X,I1,I3,I1,1X,2F4.1,1X,F5.2,1X,I6,1X,I1,2(1X,I2),1X,I3,1X,
    1I4,7X,A1,1X,I4,1X,2A3,1X,F5.2)
5003 FORMAT(1X,I1.I3,I1,2(F6.2,F7.2,F6.1,12X,F6.2))
5005 FORMAT(1X,I1,I3,I1,4A10,A5)
6000 FORMAT(1X,///,1X,*TOTAL CARBON BAG 1 =*,F8.2,* GRAMS*,5X,
    1*TOTAL CARBON BAG 2 =*,F8.2,* GRAMS*,5X,*TOTAL CARBON BAG 3 =*,
    2F8.2,* GRAMS*,/,1X,*TOTAL CARBON IN EXHAUST =*,F8.2,* GRAMS*)
6002 FORMAT(1X,*ESTIMATED FUEL WEIGHT =*,F6.2,*LB.*)
6003 FORMAT(5X,*TOTAL CVS FLOW =*,F8.1,* STD. CU. METRES*)
6012 FORMAT(/,5X,*CARBON BALANCE FUEL CONSUMPTION =*,F6.2,* LITRES PER
    1HUNDRED KILOMETRES*)
C              JPUNCH....COUNTER OF CARDS PUNCHED
C              IBUF......PRINTING ARRAY
C              JR........POINTER TO ROW IN PRINT ARRAY
C              JC,JD.....POINTER TO COLUMNS IN PRINT ARRAY
      JR=0
C
C         STORE LINE HEADINGS IN PRINT ARRAY
C
      DO 20 K1=1,4
       DO 18 K2=1,2
        DO 16 K4=1,2
         K3=K4
         JC=1
         JR=JR+1
          IBUF(JR,JC)=ITA(K1)
         JC=JC+1
          IBUF(JR,JC)=ITB(K2)
         JC=JC+1
       IF( K1 .EQ. 3 .AND.  K4 .EQ. 2) K3=3
          IBUF(JR,JC)=ITC(K3)
         JC=JC+1
          IBUF(JR,JC)=ITD(K4)
   16 CONTINUE
   18 CONTINUE
   20 CONTINUE
      JRR=JR+1
      DO 24 K2=3,4
       K3=K2+1
       DO 22 K1=1,4
      IF(K1 .EQ. 3 .AND. K2 .EQ. 3) K3=6
        JC=1
         IBUF(JRR,JC)=ITA(K1)
        JC=JC+1
         IBUF(JRR,JC)=ITB(K2)
        JC=JC+1
         IBUF(JRR,JC)=ITC(K3)
        JC=JC+1
      K3=K2+1
         IBUF(JRR,JC)=ITD(2)
        JRR=JRR+1
   22 CONTINUE
   24 CONTINUE
C
C          READ INITIAL DATA FOR A TEST
C
   25 READ 1001,   ICN,IUN,ITN,IDY,IMO,IYR,MFC,VMOD,VID,MODYR,IDISP,ARL,
     1NCYL,JTC,IWT,ICWT, GVW,IGNT,ISP, GEAR,IDSP,IAC,IEVS,IET,COMENTS
```

```
      IF(EOF,60) 100,26
   26 DISPM=IDISP*.01639
      IWT = IWT* 0.4536
      ICWTM=ICWT*.4536
      GVMM=GVM*.4536
      ARL = ARL * 0.7457
      PRINT 2001
      PRINT 2111, IUN,ITN,IDY,IMO,IYR,MFC,MODYR,VMOD, DISPM,NCYL,IWT,
     1 ARL,VID,COMENTS
      READ 1003, (ICAN(IT),EIWT(IT),FWT(IT),IT=1,3)
      IT=3
      IF(EIWT(3) .EQ. 0 .AND.  FWT(3) .EQ. 0) IT=2
      READ 1004,    KO,PBAR,DBULB,WBULB,ITP,PI,DP,DRV,OPR,ICVS
C
C  CALCULATION FOR ABSOLUTE AND RELATIVE HUMIDITY
      TWBK     = (5./9.) * (WBULB  - 32.) + 273.16
      SM = (-7.51152E3 * TWBK    **(-1.)) + 96.5389644 +(2.3948970E-2*
     1      TWBK    ) + (-1.1654551E-5 * TWBK    **2) + (-1.2810336E-8*
     2      TWBK    **3) + (2.0998405E-11 *TWBK    **4)
      TERM =  SM - 12.150799 * ALOG(TWBK    )
      PWB = 2.953E-4 * EXP(TERM)
      A =  3.67E-4 * (1. + 0.00064*(WBULB  -32.))
      PV = PWB - (A*PBAR*(DBULB-WBULB))
      H     = (4347.8 *PV)/(PBAR    -PV)
      TDBK     =(5./9.) * (DBULB - 32.) + 273.16
      SMD = (-7.51152E3 * TDBK    **(-1.)) + 96.5389644 +(2.3998970E-2*
     1       TDBK    ) + (-1.1654551E-5 * TDBK    **2) + (-1.2810336E-8*
     2       TDBK    **3) + (2.0998405E-11 *TDBK    **4)
      TERMD= SMD -12.150799 * ALOG(TDBK    )
      PDB = 2.953E-4 * EXP(TERMD)
      R     =(PV/PDB) * 100.
C       CALCULATION OF EVAPORATIVE EMISSIONS
C
C         CANISTERS USED TO COLLECT EVAPORATIVE EMISSIONS ARE WEIGHED
C         BEFORE AND AFTER EACH TEST.  THE WEIGHTS SUBTRACTED GENERATE
C         THE TOTAL EVAPORATIVE EMISSION.
C
C           TEEM.....TOTAL EVAPORATIVE EMISSIONS
C            IEWT....INITIAL WEIGHT
C            FWT.....FINAL WEIGHT
C
      TEEM=0
      DO 30 K=1,IT
       DIF(K)=FWT(K)-EIWT(K)
       TEEM=TEEM+ DIF(K)
   30 CONTINUE
      PBARMM=PBAR*25.4
      WBULBM=(WBULB-32.)/1.8
      DBULBM=(DBULB-32.)/1.8
      HM=.14286*H
      PRINT 2002,PBARMM,WBULBM,DBULBM,HM,R
      TVOL = 0.
      IF(FWT(1).EQ.0) GO TO 38
      PRINT 2009
      IF(IT .EQ. 2) GO TO 35
      PRINT 2022, (FWT(K),K=1,IT),(EIWT(K1),K1=1,IT),(DIF(K2),K2=1,IT),
     1TEEM
      GO TO 38
   35 PRINT 2222, (FWT(K),K=1,IT),(EIWT(K1),K1=1,IT),(DIF(K2),K2=1,IT),
     1TEEM
C
C       CALCULAIONS TO GENERATE EXHAUST EMISSIONS
```

```
C
C         HC........HYDROCARBON CONCENTRATIONS
C         PNO.......OXIDES OF NITROGEN CONCENTRATIONS
C         CO........CARBON MONOIDE CONCENTRATIONS
C         CO2.......CARBON DIOXIDE CONCENTRATIONS
C          SUBSCRIPTS
C          (1)......CONCENTRATION OF THE DILUTE AIR (BACKGROUND)
C          (2)......CONCENTRATION OF THE DILUTE EXHAUST SAMPLE (SAMPLE)
C           R.......SIGNIFIES RANGE SCALE AS OPPOSED TO METER READING
C       CALCULATION OF VMIX
C
C         VO........VOLUME OF GAS PUMPED BY THE POSITIVE DISPLACEMENT
C                   PUMP, IN CUBIC FEET PER REVOLUTION
C         TP........AVERAGE TEMP. OF DILUTE EXHAUST ENTERING POSITIVE
C                   DISPLACEMENT PUMP DURING TEST IN DEGREES RANKIN
C         VMIX......TOTAL DILUTE EXHAUST VOLUME IN CUBIC FEET
C         N.........NUMBER OF REVOLUTIONS OF THE POSITIVE DISPLACEMENT
C                   PUMP DURING THE TEST PHASE
C         DP........BLOWER DIFFERENTIAL PRESSURE IN INCHES H20
C
   38 DO 70 ICT=1,3
       DO 40 I=1,2
        READ 1005,   HC(I),HCR(I),CO(I),COR(I),CO2(I),CO2R(I),PNO(I),
     1       NOXR(I),NBLW,SECND
 1005 FORMAT(2X,4(F6.0,I2),I6,F7.0)
      IF(I .EQ. 1) N(ICT)=NBLW
      IF(I.EQ.1) TIME =SECND
   40 CONTINUE
      RD = TIME/ 60.
      RTP = ITP
        TP = ITP + 460.
        PBARM = PBAR * 25.4
        G1A = PBARM - (PI * 1.868)
      RPM = N(ICT)/RD
      DPM = DP * .07355
      G1B = G1A/25.4
      X = (SQRT((TP*DPM)/G1B))/RPM
      GO TO(390,391,392,393) ICVS
  390 PRINT 2999
      GO TO 100
  391 PRINT 2999
      GO TO 100
  392 CALL VOLUM3(RPM,X,RTP,VO)
      GO TO 400
  393 CALL VOLUM4(RPM,X,RTP,VO)
  400 VMIX = VO * N(ICT)* (G1A/760) * (528/TP)
      TVOL = TVOL + VMIX
      VACT = VO * N(ICT)
C
C          CURVE OF METER READING VS CONCENTRATION
C
  402 IF(HCR(2).LT.10) GO TO 405
      HC(2) =(HC(2)*100.)/(6.4444*TIME)
      HCR(2) = HCR(2) - 10
  405 DO 67 I=1,2
      KK=HCR(I)
      GO TO (41,42,43,44,445,446,447,448) KK
   41 VH(I)= HC(I)/2
       GO TO 45
   42 VH(I)= HC(I) * 2.
       GO TO 45
   43 VH(I)= HC(I) * 4.
```

```
      GO TO 45                                                               +0249
   44 YH(I)= HC(I) * 8.                                                      +0250
      GO TO 45                                                               +0251
  445 YH(I)= HC(I) * 16.                                                     +0252
      GO TO 45                                                               +0253
  446 YH(I)= HC(I) * 32.                                                     +0254
      GO TO 45                                                               +0255
  447 YH(I)=HC(I)*64.                                                        +0256
      GO TO 45                                                               +0257
  448 YH(I)=HC(I)*128.                                                       +0258
   45 KK=COR(I)                                                              +0259
      IF(KK.LT.10) GO TO 46                                                  +0260
      KK = KK - 7                                                            +0261
   46 GO TO (47,48,49,491,492,493) KK                                        +0262
   47 YC(I) =CO(I)/(((-2.8267935E-09 * CO(I) + 4.1844673E-07) * CO(I)   11/02/77+0263
     1        - 1.3529486E-04) * CO(I) + 1.7890988E-02)                 11/02/77+0264
      GO TO 50                                                               +0265
   48 YC(I) =CO(I)/((( 3.6568731E-09 * CO(I) - 5.6201298E-07) * CO(I)   11/02/77+0266
     1        - 9.2561417E-05) * CO(I) + 2.6462377E-02)                 11/02/77+0267
      GO TO 50                                                               +0268
   49 YC(I) =CO(I)/((( 2.6862029E-09 * CO(I) - 1.0952589E-06) * CO(I)   11/02/77+0269
     1        - 2.0617028E-05) * CO(I) + 4.4315249E-02)                 11/02/77+0270
      GO TO 50                                                               +0271
  491 YC(I) =CO(I) /(((5.9197299E-09  *CO(I)- 3.7317277E-06)*CO(I)      7/15/77 +0272
     1        -1.1291418E-03)*CO(I) +3.2972350E-01)                     7/15/77 +0273
      GO TO 50                                                               +0274
  492 YC(I) =CO(I) /(((-5.3302793E-07 *CO(I)+ 9.4739183E-05)*CO(I)      7/15/77 +0275
     1        -6.1342449E-03)*CO(I) +5.9016863E-01)                     7/15/77 +0276
      GO TO 50                                                               +0277
  493 YC(I) = CO(I)/(((2.1972879E-07 *CO(I) -5.5539675E-05) *CO(I)      9/13/77+0278
     1        +3.0128029E-03) *CO(I) + 1.0101093)                            +0279
   50 KK=CO2R(I)                                                             +0280
      GO TO  (52,53,54) KK                                                   +0281
C  *** THESE EQUATIONS FOR BAG CART CO2  S/N 201056 CALIB. EFFECTIVE 9/8/76  +0282
   52 YC2(I) = CO2(I)/(((-3.3427359E-06 * CO2(I) + 9.6588897E-04)*CO2(I)  9/8/76+0283
     1          -1.4310349E-01)* CO2(I) + 1.4202198E+01)                  9/8/76+0284
      GO TO 56                                                               +0285
   53 YC2(I) = CO2(I)/(((8.8979686E-07 * CO2(I) + 1.9345774E-04)* CO2(I)  9/8/76+0286
     1          -1.3142952E-01) * CO2(I) + 2.7884653E+01)                 9/8/76+0287
      GO TO 56                                                               +0288
   54 YC2(I) = CO2(I)/(((-5.8169934E-07 * CO2(I) + 8.0530448E-04)*CO2(I)  9/8/76+0289
     1          -2.0480738E-01) * CO2(I) + 6.5961661E+01)                 9/8/76+0290
   56 KK=NOXR(I)                                                             +0291
      GO TO (58,59,60,61) KK                                                 +0292
   58  YN(I)=0.3 * PNO(I)                                                    +0293
       GO TO 67                                                              +0294
   59  YN(I)=PNO(I)                                                          +0295
       GO TO 67                                                              +0296
   60  YN(I)=3 * PNO(I)                                                      +0297
      GO TO 67                                                               +0298
   61 YN(I)=10*PNO(I)                                                        +0299
   67 CONTINUE                                                               +0300
C                                                                            +0301
C        CORRECTION OF CO FOR WATER VAPOR AND CO2 EXTRACTION                 +0302
C                                                                            +0303
C          COE.........CARBON MONOXIDE CONCENTRATION OF THE DILUTE           +0304
C                      EXHAUST SAMPLE VOLUME CORRECTED                       +0305
C          COD.........CARBON MONOXIDE CONCENTRATION OF THE DILUTION         +0306
C                      AIR SAMPLE                                            +0307
C                                                                            +0308
      COE = (1 - 0.01925 * YC2(2) -0.000323 *  ,  R  ) * YC(2)               +0309
      COD = (1 - 0.000323 *    R   ) * YC(1)                                 +0310
```

```
C
C        CALCULATION OF DILUTION FACTOR
C
      DF = 13.4/( YC2(2) +((YH(2)+COE)/10000.))
C
C        CALCULATION OF FINAL CONCENTRATION VALUES
C
C          HCV.......
C          COV       ....CONCENTRATIONS OF THE DILUTE AIR EXHAUST SAMPLE
C          CO2V      ....  CORRECTED FOR WATER VAPOR AND CO2 EXTRACTIONS
C          PNOV......
C
      HCV = YH(2) - YH(1)*(1-1/DF)
      COV = COE - COD*(1-1/DF)
      CO2V=YC2(2) - YC2(1) * (1-1/DF)
      PNOV=  YN(2)- YN(1)*(1-1/DF)
C
C        CALCULATION OF HUMIDITY CORRECTION FACTOR..KH
C
      XKH = 1.0/(1.0 - 0.0047 * (H-75))
C
C        MASS CALCULATIONS
C
C          HCM.......
C          COM.......
C          CO2M      ....EMISSIONS IN GRAMS PER TEST PHASE
C          PNOM......
C
      HCM(ICT)= VMIX * 16.33 * (HCV/1000000.)
      COM(ICT) = VMIX * 32.97 * (COV/1000000)
      CO2M(ICT)=VMIX * 52.07 * (CO2V/100.)
      PNOM(ICT)= VMIX * 54.16 * (PNOV/1000000) *XKH
C
C       STORE IN PRINT ARRAY
C
      JR=2
      JC=JC+1
      JD=JC-4
      DO 69 I=1,2
       JR=JR+1
         BUF(JR,JD)=HC(I)
        IBUF(JR,JC)=HCR(I)
         JR=JR+1
         BUF(JR,JD)=YH(I)
         JR=JR+3
         BUF(JR,JD)=CO(I)
        IBUF(JR,JC)=COR(I)
         JR=JR+1
         BUF(JR,JD)=YC(I)
         JR=JR+3
         BUF(JR,JD)=CO2(I)
        IBUF(JR,JC)=CO2R(I)
         JR=JR+1
         BUF(JR,JD)=YC2(I)
         JR=JR+3
         BUF(JR,JD)=PNO(I)
        IBUF(JR,JC)=NOXR(I)
         JR=JR+1
         BUF(JR,JD)=YN(I)
         IF(I .EQ. 1) JR=0
   69 CONTINUE
       JRR=JR+3
      BUF(JRR,JD)= HCV
      JRR=JRR+1
      BUF(JRR,JD)= COV
      JRR=JRR+1
      BUF(JRR,JD)=CO2V
      JRR=JRR+1
      BUF(JRR,JD)=PNOV
      JRR=JRR+1
      BUF(JRR,JD)=HCM(ICT)
      JRR=JRR+1
      BUF(JRR,JD)=COM(ICT)
      JRR=JRR+1
      BUF(JRR,JD)=CO2M(ICT)
      JRR=JRR+1
      BUF(JRR,JD)=PNOM(ICT)
   70 CONTINUE
      PIM=25.4*PI
      DPM=25.4*DP
      ITPM=(ITP-32.)/1.8
      PRINT 2003, PIM,DPM,ITPM,(N(I),I=1,3)
 2003 FORMAT(2X,*EXHAUST EMISSIONS*//72X,*BLOWER INLET PRESS., G1 *,
     1F5.1,* MM. H2O*/7X,*BLOWER DIF. PRESS., G2, *,F5.1,* MM. H2O*,28X,
     2*BLOWER INLET TEMP. *,I4,* DEG. C*//7X,*BAG RESULTS*/7X,*BAG NO.*,
     339X,*1*,16X,*2*,16X,*3*/7X,*BLOWER REVOLUTIONS*,13X,3(12X,I5))
C          HCWM.....
C          COWM......
C          CO2WM. . ....WEIGHTED MASS EMISSIONS OF EACH POLLUTANT
C          PNOWM.....
C
      PNOWM=((0.43 *PNOM(1))+PNOM(2) +(.57 *PNOM(3)))/7.5
      CO2WM=((0.43 * CO2M(1))+CO2M(2) +(.57 * CO2M(3)))/7.5
      COWM =((0.43 * COM(1))+ COM(2) +(.57 * COM(3)))/7.5
      HCWM =((0.43 * HCM(1))+ HCM(2) +(.57 * HCM(3)))/7.5
      JR1=JR+1
      DO 80 I=1,JR1,2
      PRINT 2004,(IBUF(I,J),J=1,4),(BUF(I,K),IBUF(I,K+4),K=1,3)
 2004 FORMAT(4A10,3(10X,F5.1,*/*,I1))
      IF(I .GT. 8) GO TO 72
      PRINT 2005,(IBUF(I+1,JJ),JJ=1,4),(BUF(I+1,JK),JK=1,3)
 2005 FORMAT(4A10,3(10X,F5.0,2X))
      GO TO 80
   72 IF(I .GT. 12) GO TO 74
      PRINT 2055,(IBUF(I+1,JJ),JJ=1,4),(BUF(I+1,JK),JK=1,3)
      GO TO 80
   74 PRINT 2555,(IBUF(I+1,JJ),JJ=1,4),(BUF(I+1,JK),JK=1,3)
   80 CONTINUE
      PRINT 3000
      JR1=JR+3
      JR2=JR1+1
      PRINT 2005,((IBUF(I,J),J=1,4),(BUF(I,K),K=1,3),I=JR1,JR2)
      JR2=JR2+1
      PRINT 2055,  (IBUF(JR2,J),J=1,4),(BUF(JR2,K),K=1,3)
      JR2=JR2+1
      PRINT 2555,  (IBUF(JR2,J),J=1,4),(BUF(JR2,K),K=1,3)
      PRINT 2006,((IBUF(I+4,J),J=1,4),(BUF(I+4,K),K=1,3),I=JR1,JR2)
      PRINT 2066, HCM(1),HCM(2),HCM(3)
 2066 FORMAT(8X,*HC   MASS MG*,20X,3(8X,F7.2,2X))
      HCWMM=HCWM/1.609
      COWMM=COWM/1.609
      CO2WMM=CO2WM/1.609
      PNOWMM=PNOWM/1.609
      PRINT 2007,HCWMM,COWMM,CO2WMM,PNOWMM
      EFE = 2778./((0.866*(HCWM        ))+(0.429*COWM) + (0.273*CO2WM))
      XLPHK = (3.785 * 100.)/(EFE    * 1.609)
      PRINT 6012, XLPHK
      TVOL = TVOL * 0.02832
      PRINT  6003, TVOL
      JC=4
      JPUNCH=1
      PRINT 5001,   JPUNCH,ICN,IUN,ITN,IDY,IMO,IYR,MFC,VMOD,VID,MODYR,
     1IDISP,ARL,NCYL.JTC.IWT,ICWT, GVW
      JPUNCH=JPUNCH+1
      PRINT 5002,JPUNCH,ICN,IUN,DBULB,WBULB,PBAR,KO,IAC,IEVB,IET,IGNT,
     1ISP, GEAR,IDSP,OPR,DRV,TEEM
      JPUNCH=JPUNCH+1
        J=1
      PRINT 5003,JPUNCH,ICN,IUN,(BUF(I+4,J),I=JR1,JR2),(BUF(K+4,J+1),
     1K=JR1,JR2)
      J=3
      JPUNCH=JPUNCH+1
      PRINT 5003,JPUNCH,ICN,IUN,(BUF(I+4,J),I=JR1,JR2),HCWM,COWM,CO2WM,
     1PNOWM
      JPUNCH=JPUNCH+1
      PRINT 5005,JPUNCH,ICN,IUN,COMENTS
      DO 82 I=1,3
   82 CHC(I) = HCM(I) * 0.86561
      DO 84 I=1,3
   84 CCO(I) = COM(I) * 0.42881
      DO 86 I=1,3
   86 CCO2(I)=CO2M(I) * 0.27292
      DO 88 I=1,3
   88 CB(I) = CHC(I) + CCO(I) + CCO2(I)
      TEC = CB(1) +CB(2) + CB(3)
      PRINT 6000, (CB(I),I=1,3), TEC
      EFF = TEC/(0.86561*453.6)
      PRINT 6002, EFF
      GO TO 25
  100 STOP
      END
      SUBROUTINE VOLUM3(RPM,XO,TEMP,VO)
C
C     VOLUM3 IS FOR BROWN CVS
C     COMPUTES VOLUME AS A FUNCTION OF XO, TEMPERATURE AND RPM
C     RETURNS NEGATIVE VOLUME IF RPM IS NOT CLOSE TO TABULAR VALUE
C
      DIMENSION XVT(4,5,6),TMP(5,6),RPMT(6),V(3),T(3),
     1          RPM1(20),RPM2(20),RPM3(20),RPM4(20),RPM5(20),RPM6(20)
      EQUIVALENCE (XVT(1,1,1),RPM1),(XVT(1,1,2),RPM2)
     1          , (XVT(1,1,3),RPM3),(XVT(1,1,4),RPM4)
     2          , (XVT(1,1,5),RPM5),(XVT(1,1,6),RPM6)
C
C     DEFINE XO,VO AT T1(X1,V1),T1(XN,VN),....,T5(X1,V1),T5(XN,VN)
C        FOR EACH RPM VALUE
      DATA RPM1 /0.00600,0.3082 , 0.01400, 0.2604,
     1           0.00600,0.3082 , 0.01400, 0.2604,
     2           0.00600,0.3082 , 0.01400, 0.2604,
     3           0.00600,0.3082 , 0.01400, 0.2604,
     4           0.00600,0.3082 , 0.01400, 0.2604 /
      DATA RPM2 /0.00450,0.3087 , 0.00900, 0.2798,
     1           0.00450,0.3087 , 0.00900, 0.2798,
     2           0.00450,0.3087 , 0.00900, 0.2798,
     3           0.00450,0.3087 , 0.00900, 0.2798,
     4           0.00450,0.3087 , 0.00900, 0.2798 /
      DATA  RPM3 / 20 * 0.0 /
      DATA RPM4/0.00400,0.3113 , 0.00700,0.2912,
     1           0.00400,0.3093 , 0.00700,0.2893,
     2           0.00400,0.3036 , 0.00700,0.2846,
     3           0.00400,0.3021 , 0.00700,0.2833,
     4           0.00400,0.3006 , 0.00700,0.2816 /
      DATA RPM5/0.00200 , 0.3112    , 0.00600 , 0.3075,
     1          0.00200 , 0.3112    , 0.00600 , 0.3075,
     2          0.00200 , 0.3164    , 0.00600 , 0.3105,
     3          0.00200 , 0.3169    , 0.00600 , 0.3109,
     4          0.00200 , 0.3167    , 0.00600 , 0.3107/
      DATA  RPM6 / 20 * 0.0 /
C
C     DEFINE RPM VALUES IN THE ORDER ESTABLISHED ABOVE
      DATA RPMT / 400. , 640. , 780., 870. , 1085. , 1160. /
C
C     DEFINE T1,T2,....T5 FOR EACH RPM VALUE IN ORDER ESTABLISHED ABOVE
      DATA TMP  / 70. , 85. , 95. , 115., 130. ,
     1            70. , 85. , 95. , 115., 130. ,
     2            70. , 85. , 95. , 115., 130. ,
     3            70. , 85. , 95. , 115., 130. ,
     4            70. , 76. , 110., 125., 139. ,
     5            70. , 85. , 95. , 115., 130.  /
C
C     SELECT TABULAR TEMPERATURE VALUE NEAREST TO GIVEN VALUE
      DMIN=1000.
      DO 20 I=1,6
      DIF=ABS(RPM-RPMT(I))
      IF(DIF .GT. DMIN) GO TO 20
      IRPM=I
      DMIN=DIF
   20 CONTINUE
      IF(TEMP .LT. TMP(1,IRPM)) TEMP=TMP(1,IRPM)
      IF(TEMP .GT. TMP(5,IRPM)) TEMP=TMP(5,IRPM)
      ERR=1.0
      IF(DMIN .GT. (0.05*RPMT(IRPM))) ERR=-1.0
      IT=0
      IF(TEMP .GT. TMP(3,IRPM)) IT=2
C
C     INTERPOLATE LINEARLY TO FIND V(I) VALUES FROM T(I) AT X0
      DO 50 J=1,3
      V(J)=XVT(2,J+IT,IRPM)+(X0-XVT(1,J+IT,IRPM))*(XVT(4,J+IT,IRPM)
     1   -XVT(2,J+IT,IRPM))/(XVT(3,J+IT,IRPM)-XVT(1,J+IT,IRPM))
      T(J)=TMP(J+IT,IRPM)
   50 CONTINUE
C
C     COMPUTE V0 BY 2ND ORDER INTERPOLATION USING V(I) AND T(I)
      V0=ERR*FLAGR(T,V,TEMP,2,1,3)
      RETURN
      END
      SUBROUTINE VOLUM4(RPM,X0,TEMP,V0)
C
C     COMPUTES VOLUME AS A FUNCTION OF X0, TEMPERATURE AND RPM
C     RETURNS NEGATIVE VOLUME IF RPM IS NOT CLOSE TO TABULAR VALUE
C
      DIMENSION XVT(4,5,6),TMP(5,6),RPMT(6),V(3),T(3),
     1          RPM1(20),RPM2(20),RPM3(20),RPM4(20),RPM5(20),RPM6(20)
      EQUIVALENCE (XVT(1,1,1),RPM1),(XVT(1,1,2),RPM2)
     1          , (XVT(1,1,3),RPM3),(XVT(1,1,4),RPM4)
     2          , (XVT(1,1,5),RPM5),(XVT(1,1,6),RPM6)
C
C     DEFINE X0,V0 AT T1(X1,V1),T1(XN,VN),....T5(X1,V1),T5(XN,VN)
C        FOR EACH RPM VALUE
```

```
      DATA RPM1 / 0.0020,0.3236 , 0.0038,0.3179 ,
     1            0.0020,0.3236 , 0.0038,0.3179 ,
     2            0.0020,0.3236 , 0.0038,0.3179 ,
     3            0.0020,0.3236 , 0.0038,0.3179 ,
     4            0.0020,0.3236 , 0.0038,0.3179 /
      DATA RPM2 /  20*0.0  /
      DATA RPM3 /  20*0.0  /
      DATA RPM4 /  20*0.0  /
      DATA RPM5 /  20*0.0  /
      DATA RPM6 /  20*0.0  /
C
C     DEFINE RPM VALUES IN THE ORDER ESTABLISHED ABOVE
      DATA RPMT / 1630. ,   0.0 , 0.0 , 0.0 , 0.0 , 0.0 /
C
C     DEFINE T1,T2,....,T5 FOR EACH RPM VALUE IN ORDER ESTABLISHED ABOVE
      DATA TMP / 70. , 90. , 110. , 130. , 150.
     1         , 25*0.0  /
C
C     SELECT TABULAR TEMPERATURE VALUE NEAREST TO GIVEN VALUE
      DMIN=1000.
      DO 20 I=1,6
      DIF=ABS(RPM-RPMT(I))
      IF(DIF .GT. DMIN) GO TO 20
      IRPM=I
      DMIN=DIF
   20 CONTINUE
      IF(TEMP .LT. TMP(1,IRPM)) TEMP=TMP(1,IRPM)
      IF(TEMP .GT. TMP(5,IRPM)) TEMP=TMP(5,IRPM)
      ERR=1.0
      IF(DMIN .GT. (0.05*RPMT(IRPM))) ERR=-1.0
      IT=0
      IF(TEMP .GT. TMP(3,IRPM)) IT=2
C
C     INTERPOLATE LINEARLY TO FIND V(I) VALUES FROM T(I) AT X0
      DO 50 J=1,3
      V(J)=XVT(2,J+IT,IRPM)+(X0-XVT(1,J+IT,IRPM))*(XVT(4,J+IT,IRPM)
     1   -XVT(2,J+IT,IRPM))/(XVT(3,J+IT,IRPM)-XVT(1,J+IT,IRPM))
      T(J)=TMP(J+IT,IRPM)
   50 CONTINUE
C
C     COMPUTE V0 BY 2ND ORDER INTERPOLATION USING V(I) AND T(I)
      V0=ERR*FLAGR(T,V,TEMP,2,1,3)
      RETURN
      END
      FUNCTION FLAGR ( X,Y,XARG,IDEG,MIN,N )
C
C      FLAGR USES THE LAGRANGE FORMULA TO EVALUATE THE INTERPOLATING
C      POLYNOMIAL OF DEGREE IDEG FOR ARGUMENT XARG USING THE DATA
C      VALUES X(MIN)...X(MAX) AND Y(MIN)...Y(MAX) WHERE
C      MAX = MIN + IDEG.  X(I) IS ASSUMED TO BE IN ASCENDING
C      ORDER, AND SUBSCRIPT CHECKING IS PERFORMED.  TERM IS
C      A VARIABLE WHICH CONTAINS SUCCESSIVELY EACH TERM OF THE
C      LAGRANGE FORMULA.  THE FINAL VALUE OF YEST IS THE INTERPOLATED
C      VALUE.  SEE CARNAHAN ET AL,APPL.NUM.METH.,WILEY,1969,P.29.
C
      DIMENSION X(1), Y(1)
C
C     ..... LOCATE AN X-VALUE NEAR XARG .....
      DO 20 I=1,N
      IF (X(I) .LT. XARG)  GO TO 20
      MIN = I - IDEG/2
      MAX = MIN + IDEG
      GO TO 30
   20 CONTINUE
C
C     ..... CHECK SUBSCRIPT BOUNDS .....
   30 CONTINUE
      IF (MIN .GT. 0)  GO TO 40
      MIN = 1
      MAX = MIN + IDEG
      GO TO 50
   40 CONTINUE
      IF (MAX .LE. N)  GO TO 50
      MAX = N
      MIN = MAX - IDEG
   50 CONTINUE
C
C     ..... COMPUTE VALUE OF FACTOR .....
      FACTOR = 1.0
      DO 60  J=MIN,MAX
      IF (XARG .NE. X(J))  GO TO 60
      FLAGR = Y(J)
      RETURN
   60 FACTOR = FACTOR*(XARG - X(J))
C
C     ..... EVALUATE INTERPOLATING POLYNOMIAL .....
      YEST = 0.0
      DO 80  I=MIN,MAX
      TERM = Y(I)*FACTOR/(XARG - X(I))
      DO 70  J=MIN,MAX
      IF (I .NE. J)  TERM = TERM/(X(I) - X(J))
   70 CONTINUE
      YEST = YEST + TERM
   80 CONTINUE
      FLAGR = YEST
      RETURN
      END
*
*
```

```
     1    -XVT(2,J+IT,IRPM))/(XVT(3,J+IT,IRPM)-XVT(1,J+IT,IRPM))
      T(J)=TMP(J+IT,IRPM)
   50 CONTINUE
C
C     COMPUTE VO BY 2ND ORDER INTERPOLATION USING V(I) AND T(I)
      VO=ERR*FLAGR(T,V,TEMP,2,1,3)
      RETURN
      END
      FUNCTION FLAGR ( X,Y,XARG,IDEG,MIN,N )
C
C      FLAGR USES THE LAGRANGE FORMULA TO EVALUATE THE INTERPOLATING
C      POLYNOMIAL OF DEGREE IDEG FOR ARGUMENT XARG USING THE DATA
C      VALUES X(MIN)...X(MAX) AND Y(MIN)...Y(MAX) WHERE
C      MAX = MIN + IDEG.  X(I) IS ASSUMED TO BE IN ASCENDING
C      ORDER, AND SUBSCRIPT CHECKING IS PERFORMED.  TERM IS
C      A VARIABLE WHICH CONTAINS SUCCESSIVELY EACH TERM OF THE
C      LAGRANGE FORMULA.  THE FINAL VALUE OF YEST IS THE INTERPOLATED
C      VALUE.  SEE CARNAHAN ET AL,APPL.NUM.METH.,WILEY,1969,P.29.
C
      DIMENSION X(1), Y(1)
C
C     ..... LOCATE AN X-VALUE NEAR XARG .....
      DO 20 I=1,N
      IF (X(I) .LT. XARG)  GO TO 20
      MIN = I - IDEG/2
      MAX = MIN + IDEG
      GO TO 30
   20 CONTINUE
C
C     ..... CHECK SUBSCRIPT BOUNDS .....
   30 CONTINUE
      IF (MIN .GT. 0)  GO TO 40
      MIN = 1
      MAX = MIN + IDEG
      GO TO 50
   40 CONTINUE
      IF (MAX .LE. N)  GO TO 50
      MAX = N
      MIN = MAX - IDEG
   50 CONTINUE
C
C     ..... COMPUTE VALUE OF FACTOR .....
      FACTOR = 1.0
      DO 60  J=MIN,MAX
      IF (XARG .NE. X(J))  GO TO 60
      FLAGR = Y(J)
      RETURN
   60 FACTOR = FACTOR*(XARG - X(J))
C
C     ..... EVALUATE INTERPOLATING POLYNOMIAL .....
      YEST = 0.0
      DO 80  I=MIN,MAX
      TERM = Y(I)*FACTOR/(XARG - X(I))
      DO 70  J=MIN,MAX
      IF (I .NE. J)  TERM = TERM/(X(I) - X(J))
   70 CONTINUE
      YEST = YEST + TERM
   80 CONTINUE
      FLAGR = YEST
      RETURN
C
      END
      IF(TEMP .GT. TMP(3,IRPM)) IT=2
C
C     INTERPOLATE LINEARLY TO FIND V(I) VALUES FROM T(I) AT XO
      DO 50 J=1,3
      V(J)=XVT(2,J+IT,IRPM)+(XO-XVT(1,J+IT,IRPM))*(XVT(4,J+IT,IRPM)
     1   -XVT(2,J+IT,IRPM))/(XVT(3,J+IT,IRPM)-XVT(1,J+IT,IRPM))
      T(J)=TMP(J+IT,IRPM)
   50 CONTINUE
C
C     COMPUTE VO BY 2ND ORDER INTERPOLATION USING V(I) AND T(I)
      VO=ERR*FLAGR(T,V,TEMP,2,1,3)
      RETURN
      END
      SUBROUTINE VOLUM4(RPM,XO,TEMP,VO)
C
C     COMPUTES VOLUME AS A FUNCTION OF XO, TEMPERATURE AND RPM
C     RETURNS NEGATIVE VOLUME IF RPM IS NOT CLOSE TO TABULAR VALUE
C
      DIMENSION XVT(4,5,6),TMP(5,6),RPMT(6),V(3),T(3),
     1          RPM1(20),RPM2(20),RPM3(20),RPM4(20),RPM5(20),RPM6(20)
      EQUIVALENCE (XVT(1,1,1),RPM1),(XVT(1,1,2),RPM2)
     1          , (XVT(1,1,3),RPM3),(XVT(1,1,4),RPM4)
     2          , (XVT(1,1,5),RPM5),(XVT(1,1,6),RPM6)
C
C     DEFINE XO,VO AT T1(X1,V1),T1(XN,VN),....,T5(X1,V1),T5(XN,VN)
C        FOR EACH RPM VALUE
      DATA RPM1 / 0.0020,0.3236 , 0.0038,0.3174 ,
     1            0.0020,0.3236 , 0.0038,0.3174 ,
     2            0.0020,0.3236 , 0.0038,0.3174 ,
     3            0.0020,0.3236 , 0.0038,0.3174 ,
     4            0.0020,0.3236 , 0.0038,0.3174 /
      DATA RPM2 /  20*0.0  /
      DATA RPM3 /  20*0.0  /
      DATA RPM4 /  20*0.0  /
      DATA RPM5 /  20*0.0  /
      DATA RPM6 /  20*0.0  /
C
C     DEFINE RPM VALUES IN THE ORDER ESTABLISHED ABOVE
      DATA RPMT / 1630. ,   0.0 , 0.0 , 0.0 , 0.0 , 0.0 /
C
C     DEFINE T1,T2,....,T5 FOR EACH RPM VALUE IN ORDER ESTABLISHED ABOVE
      DATA TMP / 70. , 90. , 110. , 130. , 150.
     1         , 25*0.0  /
C
C     SELECT TABULAR TEMPERATURE VALUE NEAREST TO GIVEN VALUE
      DMIN=1000.
      DO 20 I=1,6
      DIF=ABS(RPM-RPMT(I))
      IF(DIF .GT. DMIN) GO TO 20
      IRPM=I
      DMIN=DIF
   20 CONTINUE
      IF(TEMP .LT. TMP(1,IRPM)) TEMP=TMP(1,IRPM)
      IF(TEMP .GT. TMP(5,IRPM)) TEMP=TMP(5,IRPM)
      ERR=1.0
      IF(DMIN .GT. (0.05*RPMT(IRPM))) ERR=-1.0
      IT=0
      IF(TEMP .GT. TMP(3,IRPM)) IT=2
C
C     INTERPOLATE LINEARLY TO FIND V(I) VALUES FROM T(I) AT XO
      DO 50 J=1,3
      V(J)=XVT(2,J+IT,IRPM)+(XO-XVT(1,J+IT,IRPM))*(XVT(4,J+IT,IRPM)
      END
      SUBROUTINE VOLUM3(RPM,XO,TEMP,VO)
C
C     VOLUM3 IS FOR BROWN CVS
C     COMPUTES VOLUME AS A FUNCTION OF XO, TEMPERATURE AND RPM
C     RETURNS NEGATIVE VOLUME IF RPM IS NOT CLOSE TO TABULAR VALUE
C
      DIMENSION XVT(4,5,6),TMP(5,6),RPMT(6),V(3),T(3),
     1          RPM1(20),RPM2(20),RPM3(20),RPM4(20),RPM5(20),RPM6(20)
      EQUIVALENCE (XVT(1,1,1),RPM1),(XVT(1,1,2),RPM2)
     1          , (XVT(1,1,3),RPM3),(XVT(1,1,4),RPM4)
     2          , (XVT(1,1,5),RPM5),(XVT(1,1,6),RPM6)
C
C     DEFINE XO,VO AT T1(X1,V1),T1(XN,VN),....,T5(X1,V1),T5(XN,VN)
C        FOR EACH RPM VALUE
      DATA RPM1 /0.00600,0.3082 , 0.01400, 0.2604,
     1           0.00600,0.3082 , 0.01400, 0.2604,
     2           0.00600,0.3082 , 0.01400, 0.2604,
     3           0.00600,0.3082 , 0.01400, 0.2604,
     4           0.00600,0.3082 , 0.01400, 0.2604 /
      DATA RPM2 /0.00450,0.3087 , 0.00900, 0.2798,
     1           0.00450,0.3087 , 0.00900, 0.2798,
     2           0.00450,0.3087 , 0.00900, 0.2798,
     3           0.00450,0.3087 , 0.00900, 0.2798,
     4           0.00450,0.3087 , 0.00900, 0.2798 /
      DATA  RPM3 / 20 * 0.0 /
      DATA RPM4/0.00400,0.3113 , 0.00700,0.2912,
     1          0.00400,0.3093 , 0.00700,0.2893,
     2          0.00400,0.3036 , 0.00700,0.2846,
     3          0.00400,0.3021 , 0.00700,0.2833,
     4          0.00400,0.3006 , 0.00700,0.2816 /
      DATA RPM5/0.00200 , 0.3112    , 0.00600 , 0.3075,
     1         0.00200 , 0.3112    , 0.00600 , 0.3075,
     2         0.00200 , 0.3164    , 0.00600 , 0.3105,
     3         0.00200 , 0.3169    , 0.00600 , 0.3109,
     4         0.00200 , 0.3167    , 0.00600 , 0.3107/
      DATA  RPM6 / 20 * 0.0 /
C
C     DEFINE RPM VALUES IN THE ORDER ESTABLISHED ABOVE
      DATA RPMT / 400. , 640. , 780., 870. , 1085. , 1160. /
C
C     DEFINE T1,T2....T5 FOR EACH RPM VALUE IN ORDER ESTABLISHED ABOVE
      DATA TMP  / 70. , 85. , 95. , 115., 130. ,
     1            70. , 85. , 95. , 115., 130. ,
     2            70. , 85. , 95. , 115., 130. ,
     3            70. , 85. , 95. , 115., 130. ,
     4            70. , 76. , 110., 125., 139. ,
     5            70. , 85. , 95. , 115., 130.  /
C
C     SELECT TABULAR TEMPERATURE VALUE NEAREST TO GIVEN VALUE
      DMIN=1000.
      DO 20 I=1,6
      DIF=ABS(RPM-RPMT(I))
      IF(DIF .GT. DMIN) GO TO 20
      IRPM=I
      DMIN=DIF
   20 CONTINUE
      IF(TEMP .LT. TMP(1,IRPM)) TEMP=TMP(1,IRPM)
      IF(TEMP .GT. TMP(5,IRPM)) TEMP=TMP(5,IRPM)
      ERR=1.0
      IF(DMIN .GT. (0.05*RPMT(IRPM))) ERR=-1.0 .
      IT=0
```

```
C
C     DEFINE X0,V0 AT T1(X1,V1),T1(XN,VN),....,T5(X1,V1),T5(XN,VN)
C        FOR EACH RPM VALUE
      DATA RPM1 / 0.001, 0.826 , 0.003, 0.752 ,
     1            0.001, 0.835 , 0.003, 0.760 ,
     2            0.001, 0.846 , 0.003, 0.770 ,
     3            0.001, 0.846 , 0.003, 0.770 ,
     4            0.001, 0.846 , 0.003, 0.770  /
      DATA RPM2 / 0.001, 0.000 , 0.003, 0.000 ,
     1            0.001, 0.000 , 0.003, 0.000 ,
     2            0.001, 0.000 , 0.003, 0.000 ,
     3            0.001, 0.000 , 0.003, 0.000 ,
     4            0.001, 0.000 , 0.003, 0.000  /
      DATA RPM3 / 20*0.0 /
      DATA RPM4 / 20*0.0 /
      DATA RPM5 / 0.0008, 0.0801 ,0.0016, 0.0762,
     1            0.0008, 0.0801 ,0.0016, 0.0762,
     2            0.0008, 0.0801 ,0.0016, 0.0762,
     3            0.0008, 0.0801 ,0.0016, 0.0762,
     4            0.0008, 0.0801 ,0.0016, 0.0762 /
      DATA RPM6 / 0.0008, 0.0798 ,0.0016, 0.0757,
     1            0.0008, 0.0798 ,0.0016, 0.0757,
     2            0.0008, 0.0798 ,0.0016, 0.0757,
     3            0.0008, 0.0798 ,0.0016, 0.0757,
     4            0.0008, 0.0798 ,0.0016, 0.0757 /
C
C     DEFINE RPM VALUES IN THE ORDER ESTABLISHED ABOVE
      DATA RPMT / 1310., 2120. , 2490. , 2920. , 3890. , 4890. /
C
C     DEFINE T1,T2,....,T5 FOR EACH RPM VALUE IN ORDER ESTABLISHED ABOVE
      DATA TMP  / 70., 90., 110., 130., 150.,
     1            70., 90., 110., 130., 150.,
     2            70., 90., 110., 130., 150.,
     3            70., 90., 110., 130., 150.,
     4            70., 90., 110., 130., 150.,
     5            70., 90., 110., 130., 150. /
C
C     SELECT TABULAR TEMPERATURE VALUE NEAREST TO GIVEN VALUE
      DMIN=1000.
      DO 20 I=1,6
      DIF=ABS(RPM-RPMT(I))
      IF(DIF .GT. DMIN) GO TO 20
      IRPM=I
      DMIN=DIF
   20 CONTINUE
      IF(TEMP .LT. TMP(1,IRPM)) TEMP=TMP(1,IRPM)
      IF(TEMP .GT. TMP(5,IRPM)) TEMP=TMP(5,IRPM)
      ERR=1.0
      IF(DMIN .GT. (0.05*RPMT(IRPM))) ERR=-1.0
      IT=0
      IF(TEMP .GT. TMP(3,IRPM)) IT=2
C
C     INTERPOLATE LINEARLY TO FIND V(I) VALUES FROM T(I) AT X0
      DO 50 J=1,3
      V(J)=XVT(2,J+IT,IRPM)+(X0-XVT(1,J+IT,IRPM))*(XVT(4,J+IT,IRPM)
     1   -XVT(2,J+IT,IRPM))/(XVT(3,J+IT,IRPM)-XVT(1,J+IT,IRPM))
      T(J)=TMP(J+IT,IRPM)
   50 CONTINUE
C
C     COMPUTE V0 BY 2ND ORDER INTERPOLATION USING V(I) AND T(I)
      V0=ERR*FLAGR(T,V,TEMP,2,1,3)
      RETURN
      PC = PBAR/CVINP
      DO 70 I= 1,2
      S3SM  =  (S3STD(I)*S3FA(I)*S3DF(I))/S3SA(I)
      S3MF(I)=  S3SM * SML(I)
      S3MCF =   S3MF(I)/S3VF(I)
      TEMC  =   TP/(S3TEM(I)+460)
      S4MCF(I)= S3MCF * PC * TEMC
   70 CONTINUE
      BAF =(VACT *(DF-1.))/DF
      S4BGD = S4MCF(1) * BAF
      S4S   = S4MCF(2) * VACT
      H2S4B = S4BGD * 1.0210
      H2S4S = S4S * 1.0210
      H2S4  =(H2S4S -H2S4B)/ 1000.
      S4= H2S4/1.0210
      SH2S4 =(H2S4 * 0.327)/1000.
      S4PK =  S4/(MILES* 1.609)
      H2S4PK = H2S4 /(MILES * 1.609)
C
C     CALCULATIONS  FOR  SULFUR BALANCE *************
   90 WFS = FW*(PFS/100.)
      SO2S = SO2M(I) * .5005
      TSW = SO2S + SH2S4
      SO2SR =(SO2S*100.)/WFS
      SH2S4R =(SH2S4*100.)/WFS
      TSR = SO2SR + SH2S4R
      VACT = VACT * 0.028317
      PRINT 2000,ICN
      PRINT 6010, IMO,IDY,IYR,ITN,IUN,MODYR,VMOD,VID,DISPM,PBARM
      PRINT 6012, RD,XKILM,VACT
      PRINT 6014
      PRINT 6016, FILNU(2),FILNU(1),S3VF(2),S3VF(1),S3TEM(2),S3TEM(1),
     1 S3FA(2),S3FA(1),S3DF(2),S3DF(1),S3STD(2),S3STD(1),S3SA(2),
     2 S3SA(1),S3MF(2),S3MF(1)
      PRINT 6019
      VOLTEM(1)= VOLTEM(1)-460.
      VOLTEM(2)= VOLTEM(2)-460.
      PRINT 6020, SAMVOL(2),SAMVOL(1),VOLTEM(2),VOLTEM(1),S2B1A(2),
     1 S2B1A(1),S2B1D(2),S2B1D(1),S2B2A(2),S2B2A(1),S2B2D(2),S2B2D(1),
     2 S2STD(2),S2STD(1),S2SA(2),S2SA(1),S2MB1(2),S2MB1(1),S2MB2(2),
     3 S2MB2(1),YS2(2),YS2(1)
      PRINT 6022
      PRINT 6024,S4 ,H2S4 ,SO2M(1),S4PK,H2S4PK,SO2WM
      PRINT 6026
      PRINT 6028, FW, PFS
      PRINT 6030
      PRINT 6032, WFS, SO2S,SH2S4,TSW,SO2SR,SH2S4R,TSR
      PRINT  6008, TVOL
      GO TO 25
  999 STOP
      END
      SUBROUTINE VOLUM2(RPM,XO,TEMP,VO)
C     VOLUM2 IS FOR BULE CVS
C
C     COMPUTES VOLUME AS A FUNCTION OF XO, TEMPERATURE AND RPM
C     RETURNS NEGATIVE VOLUME IF RPM IS NOT CLOSE TO TABULAR VALUE
C
      DIMENSION XVT(4,5,6),TMP(5,6),RPMT(6),V(3),T(3),
     1          RPM1(20),RPM2(20),RPM3(20),RPM4(20),RPM5(20),RPM6(20)
      EQUIVALENCE (XVT(1,1,1),RPM1),(XVT(1,1,2),RPM2)
     1          , (XVT(1,1,3),RPM3),(XVT(1,1,4),RPM4)
     2          , (XVT(1,1,5),RPM5),(XVT(1,1,6),RPM6)
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C          MASS CALCULATIONS
C
C            HCM.......
C            COM.......
C            CO2M  .   ....EMISSIONS IN GRAMS PER TEST PHASE
C            PNOM......
C
      HCM(ICT) = VMIX * 16.33 * (HCV/1000000)
      COM(ICT) = VMIX * 32.97 * (COV/1000000)
      CO2M(ICT)=VMIX * 52.07 * (CO2V/100.)
      PNOM(ICT)= VMIX * 54.16 * (PNOV/1000000) *XKH
      SO2M(ICT) = VMIX *77.22 *(SO2V/1000000.)
      PRINT 2006,HCV,COV, CO2V,PNOV,SO2V,HCM(ICT),COM(ICT),CO2M(ICT),
     1PNOM(ICT),SO2M(ICT)
C
      XMPG =  MILES/(FW/6.235)
      ASPD =  MILES/(RD/60.)
      I=1
   82 CHC(I) = HCM(I) * PCTC
   84 CCO(I) = COM(I) * 0.42881
   86 CCO2(I)=CO2M(I) * 0.27292
   88 CB(I) = CHC(I) + CCO(I) + CCO2(I)
      TEC = CB(1)
      EFF = TEC/(PCTC  )
C
      I=1
      HCWM(I) =HCM(I)/MILES
      COWM(I) =COM(I)/MILES
      CO2WM(I)=CO2M(I)/MILES
      PNOWM(I)=PNOM(I)/MILES
      SO2WM = SO2M(I)/MILES
      HCWM(I) = HCWM(I)/1.609
      COWM(I) = COWM(I)/1.609
      CO2WM(I) = CO2WM(I)/1.609
      PNOWM(I) = PNOWM(I)/1.609
      SO2WM    = SO2WM/1.609
      GMHC(I) =HCM(I)/RD
      GMCO(I) =COM(I)/RD
      GMCO2(I)=CO2M(I)/RD
      GMNO(I) =PNOM(I)/RD
      GMSO2 = SO2M(I)/RD
      FW = FW * 0.4536
      EFF = EFF/1000.
      IF(FW.EQ.0) FW=EFF
      GPHC(I) =HCM(I)/FW
      GPCO(I) =COM(I)/FW
      GPCO2(I)=CO2M(I)/FW
      GPNO(I) =PNOM(I)/FW
      GPSO2 = SO2M(I)/FW
      FW= FW *1000.
      PRINT 2007, HCWM(I),COWM(I),CO2WM(I),PNOWM(I),SO2WM
      PRINT 2008,GPHC(I),GMHC(I),GPCO(I),GMCO(I),GPCO2(I),GMCO2(I),
     1GPNO(I),GMNO(I),GPSO2,GMSO2
      XKILM = MILES*1.609
      XLPHK =(FW * 3.785 * 100.)/(XKILM*FPPG* 453.6)
      PRINT 6002, XLPHK
      TVOL = VMIX * 0.02832
C
      IF(S2C.EQ.0.AND.S3C.EQ.0) GO TO 25
      IF(S3C.EQ.0) GO TO 90
C      CALCULATIONS FOR SULFATE  FROM BCA PROCEDURE
      CVINP =  PBAR -(PI* 0.07355)
   GO TO (58,59,60,61) KK
58  YN(I)=0.3 * PNO(I)
    GO TO 62
59  YN(I)=PNO(I)
    GO TO 62
60  YN(I)=3 * PNO(I)
    GO TO 62
61 YN(I)=10*PNO(I)
62 KK = SO2R(I)
   IF(KK.EQ.0) GO TO 666
   GO TO (63,64,65,66) KK
63 YS2(I) = SO2(I) * .1
   GO TO 67
64 YS2(I) = SO2(I) * 0.250
   GO TO 67
65 YS2(I) = SO2(I)
   GO TO 67
66 YS2(I) = SO2(I) * 5.
   GO TO 67
666 YS2(I) = 0.0
67 CONTINUE
   PIM = PI * 25.4
   DPM = DP * 25.4
   ITPM =  (ITP - 32.)/1.8
   VOM  = VO * 28317
   PRINT 2003, RD,PIM,DPM,ITPM,RCNT,N(1),VOM
   PRINT 2004,HC(2),HCR(2),YH(2),HC(1),HCR(1),YH(1),CO(2),COR(2),
  1YC(2),CO(1),COR(1),YC(1)
   PRINT 2005,CO2(2),CO2R(2),YC2(2),CO2(1),CO2R(1),YC2(1),
  1PNO(2),NOXR(2),YN(2),PNO(1),NOXR(1),YN(1)
C
C        CORRECTION OF CO FOR WATER VAPOR AND CO2 EXTRACTION
C
C           COE.........CARBON MONOXIDE CONCENTRATION OF THE DILUTE
C                       EXHAUST SAMPLE VOLUME CORRECTED
C           COD.........CARBON MONOXIDE CONCENTRATION OF THE DILUTION
C                       AIR SAMPLE
C
      COE = (1 - 0.01925 * YC2(2) -0.000323 *     R  ) * YC(2)
      COD = (1 - 0.000323 *    R   ) * YC(1)
C
C        CALCULATION OF DILUTION FACTOR
C
      DF = 13.4/( YC2(2) +((YH(2)+COE)/10000.))
C
C        CALCULATION OF FINAL CONCENTRATION VALUES
C
C           HCV.......,
C           COV       ,....CONCENTRATIONS OF THE DILUTE AIR EXHAUST SAMPLE
C           CO2V . . ,....  CORRECTED FOR WATER VAPOR AND CO2 EXTRACTIONS
C           PNOV......
C
      HCV = YH(2) - YH(1)*(1-1/DF)
      COV = COE - COD*(1-1/DF)
      CO2V=YC2(2) - YC2(1) * (1-1/DF)
      PNOV=  YN(2)- YN(1)*(1-1/DF)
      SO2V = YS2(2) - YS2(1)*(1-1/DF)
C
C        CALCULATION OF HUMIDITY CORRECTION FACTOR..KH
C
       XKH = 1.0/(1.0 - 0.0047 * (H-75))
C
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      SO2(I) = (YS2(I)* 100.)/25.
 4010 CONTINUE
C
C            CURVE OF METER READING VS CONCENTRATION
C
  401 IF(SO2R(2).LT.10) GO TO 402
      SO2(2) =(SO2(2)*100.)/(6.9999* TIME)
      SO2R(2) = SO2R(2) - 10
  402 IF(HCR(2).LT.10) GO TO 405
      HC(2) = (HC(2)*100)/(6.9999* TIME)
      HCR(2) = HCR(2) - 10
  405 DO 67 I=1,2
      KK=HCR(I)
      GO TO (41,42,43,44,445,446,447,448) KK
   41 YH(I)= HC(I)/2
       GO TO 45
   42 YH(I)= HC(I) * 2.
       GO TO 45
   43 YH(I)= HC(I) * 4.
      GO TO 45
   44 YH(I)= HC(I) * 8.
      GO TO 45
  445 YH(I)= HC(I) * 16.
      GO TO 45
  446 YH(I)= HC(I) * 32.
      GO TO 45
  447 YH(I)=HC(I)*64.
      GO TO 45
  448 YH(I)=HC(I)*128.
   45 KK=COR(I)
      IF(KK.LT.10) GO TO 46
      KK = KK - 7
   46 GO TO (47,48,49,491,492,493) KK
   47 YC(I) =CO(I)/(((-2.8267938E-09 * CO(I) + 4.1894673E-07) * CO(I)   11/02/77
     1        - 1.3529486E-04) * CO(I) + 1.7890988E-02)                  11/02/77
      GO TO 50
   48 YC(I) =CO(I)/((( 3.6568731E-09 * CO(I) - 5.6201298E-07) * CO(I)   11/02/77
     1        - 9.2561417E-05) * CO(I) + 2.6462377E-02)                  11/02/77
      GO TO 50
   49 YC(I) =CO(I)/((( 2.6862029E-09 * CO(I) - 1.0952589E-06) * CO(I)   11/02/77
     1        - 2.0617028E-05) * CO(I) + 4.4315249E-02)                  11/02/77
      GO TO 50
  491 YC(I) =CO(I) /(((5.9197299E-09  *CO(I)- 3.7317877E-06)*CO(I)       7/15/77
     1         -1.1291418E-03)*CO(I) +3.2972350E-01)                      7/15/77
      GO TO 50
  492 YC(I) =CO(I) /(((-5.3302793E-07 *CO(I)+ 9.4739183E-05)*CO(I)       7/15/77
     1         -6.1342449E-03)*CO(I) +5.9016863E-01)                      7/15/77
      GO TO 50
  493 YC(I) = CO(I)/(((2.1972879E-07 *CO(I) -5.5539676E-05) *CO(I)       9/13/77
     1         +3.0128029E-03) *CO(I) + 1.0101093)
   50 KK=CO2R(I)
      GO TO  (52,53,54) KK
C  *** THESE EQUATIONS FOR BAG CART CO2  S/N 201056 CALIB. EFFECTIVE 9/8/76
   52 YC2(I) = CO2(I)/(((-3.3427389E-06 * CO2(I) + 9.6588897E-04)*CO2(I)  9/8/76
     1          -1.4310349E-01)* CO2(I) + 1.4202198E+01)                  9/8/76
      GO TO 56
   53 YC2(I) = CO2(I)/(((8.8979686E-07 * CO2(I) + 1.9349774E-04)* CO2(I)  9/8/76
     1          -1.3142952E-01) * CO2(I) + 2.7884653E+01)                 9/8/76
      GO TO 56
   54 YC2(I) = CO2(I)/(((-5.8169934E-07 * CO2(I) + 8.0530448E-04)*CO2(I)  9/8/76
     1          -2.0480738E-01) * CO2(I) + 6.5961661E+01)                 9/8/76
   56 KK=NOXR(I)
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C          TP.........AVERAGE TEMP. OF DILUTE EXHAUST ENTERING POSITIVE
C                     DISPLACEMENT PUMP DURING TEST IN DEGREES RANKIN'
C          VMIX.......TOTAL DILUTE EXHAUST VOLUME IN CUBIC FEET
C          N..........NUMBER OF REVOLUTIONS OF THE POSITIVE DISPLACEMENT
C                     PUMP DURING THE TEST PHASE
C          DP.........BLOWER DIFFERENTIAL PRESSURE IN INCHES H2O
C
      ICT=1
       DO 40 I=1,2
        READ 1005,   HC(I),HCR(I),CO(I),COR(I),CO2(I),CO2R(I),PNO(I),
     1 NOXR(I),NBLW,SECND,RC,SIF,SO2(I),SO2R(I)
      IF(I .EQ. 1) N(ICT)=NBLW
      IF(I.EQ.1) TIME =SECND
      IF(I.EQ.1) RCNT = RC
      IF(I.EQ.1) PFS = SIF
   40 CONTINUE
      IF(MILES.NE.0.) GO TO 39
      MILES = RCNT/2333.691
   39 TP = ITP + 460.
      RD = TIME/60.
      RTP = ITP
        PBARM = PBAR * 25.4
        G1A = PBARM - (PI * 1.868)
      RPM = N(ICT)/RD
      DPM = DP * .07355
      G1B = G1A/25.4
      X = (SQRT((TP*DPM)/G1B))/RPM
      GO TO(390,391,392,393) ICVS
  390 PRINT 2999
      GO TO 499
  391 CALL VOLUM2(RPM,X,RTP,VO)
      GO TO 400
  392 CALL VOLUM3(RPM,X,RTP,VO)
      GO TO 400
  393 CALL VOLUM4(RPM,X,RTP,VO)
  400 VMIX = VO * N(ICT)* (G1A/760) * (528/TP)
      VACT = VO * N(ICT)
C
C      DATA FOR SO2 AND SO3 BY BCA
C
       IF(S3C.EQ.0) GO TO  4002
       DO 4001 I=1,2
       READ 1006,S3STD(I),S3SA(I),S3FA(I),S3DF(I),SML(I),S3VF(I),
      1 S3TEM(I),FILNU(I)
 4001 CONTINUE
 4002 IF(S2C.EQ.0) GO TO 401
       DO 4005 I=1,2
       READ 1007, S2STD(I),S2SA(I),S2B1A(I),S2B1D(I),S2B2A(I),S2B2D(I),
      1 SAMVOL(I),VOLTEM(I), VOLPRS(I)
 4005 CONTINUE
C
C       CALCULATIONS  FOR  SO2  PPM  FROM SO2-BCA
C
       DO 4010 I=1,2
       VOLTEM(I)= VOLTEM(I) + 460.
       VOLPRS(I)= PBAR- (.07355* VOLPRS(I))
       S2MB1(I)=(S2STD(I)*S2B1A(I)*10.*S2B1D(I))/S2SA(I)
       S2MB2(I)=(S2STD(I)*S2B2A(I)*10.*S2B2D(I))/S2SA(I)
       DS2 = 2.927 * (VOLPRS(I)/29.92) * (492/VOLTEM(I))
       S2B1C =(S2STD(I)*S2B1A(I)*S2B1D(I)*.2355)/(S2SA(I)*DS2*SAMVOL(I))
       S2B2C =(S2STD(I)*S2B2A(I)*S2B2D(I)*.2355)/(S2SA(I)*DS2*SAMVOL(I))
       YS2(I) = S2B1C + S2B2C
      JNCYL= NCYL
      TVMOD(1) = VMOD(1)
      TVMOD(2) = VMOD(2)
      TVID(1) = VID(1)
      TVID(2) = VID(2)
       DISPM = IDISP * 0.01639
      ICWTM = ICWT * 0.4536
      GVMM  = GVM * .4536
      PRINT 2000, ICN
      READ 1004,   KO,PBAR,DBULB,WBULB,ITP,PI,DP,DRV,DPR,BFW,EFW,MILES,
     1RHC,FPPG,ICVS,S2C,S3C
      PRINT 2001, IMO,IDY,IYR,ITN,IUN,MODYR,VMOD,VID,  DISPM,CYA,NCYL,
     1DRV,ICWTM,GVMM
      RHC = 1.844
      FPPG =7.07
      FPPGM= FPPG * 119.841
      DTM = MILES * 1.609
      XHCMW = 12.011 +  (RHC * 1.008)
      PCTC = 12.011 / XHCMW
      IF (MILES.EQ.10.24) MILES = 10.242
      FW = BFW - EFW
      FWM = FW * 0.4536
C
C  CALCULATION FOR ABSOLUTE AND RELATIVE HUMIDITY
C
      TC = 647.27
      PC = 218.167
      A  = 3.2437814
      B  = 5.86826E-3
      C  = 1.1702379E-8
      D  = 2.1878462E-3
      TDBK    =(5./9.) * (DBULB - 32.) + 273.16
      X  = TC - TDBK
      PDB= 29.92*PC/(10.**(X/TDBK   *((A+B*X+C*X**3)/(1+D*X))))
      TWBK    = (5./9.) * (WBULB  - 32.) + 273.16
      X  = TC - TWBK
      PWB = 29.92*PC/(10.**(X/TWBK   *((A+B*X+C*X**3)/(1+D*X))))
      DBT = DBULB
      WBT = WBULB
      R     =(PWB-(DBT   -WBT   )*(.000367*PBAR   *((WBT   +1539.)/1571.
     1)))/PDB*100.
      H     =(43.478*R    *PDB) / (PBAR   -PDB*R    /100.)
      WBULBM = (WBULB - 32.)/1.8
      DBULBM = (DBULB - 32.)/1.8
      HM = H * 0.14286
      PBARM = PBAR *25.4
      PRINT 2002, WBULBM,DBULBM,R,HM,PBARM,FWM,DTM  ,FPPGM,RHC
C
C      CALCULAIONS TO GENERATE EXHAUST EMISSIONS
C
C          HC.........HYDROCARBON CONCENTRATIONS
C          PNO........OXIDES OF NITROGEN CONCENTRATIONS
C          CO.........CARBON MONOIDE CONCENTRATIONS
C          CO2........CARBON DIOXIDE CONCENTRATIONS
C           SUBSCRIPTS
C           (1).......CONCENTRATION OF THE DILUTE AIR (BACKGROUND)
C           (2).......CONCENTRATION OF THE DILUTE EXHAUST SAMPLE (SAMPLE)
C            R........SIGNIFIES RANGE SCALE AS OPPOSED TO METER READING
C        CALCULATION OF VMIX
C
C          VO.........VOLUME OF GAS PUMPED BY THE POSITIVE DISPLACEMENT
C                     PUMP, IN CUBIC FEET PER REVOLUTION
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6018 FORMAT(/,5X,*SULFUR DIOXIDE DATA*)
6020 FORMAT(/,6X,*SAMPLE VOL. CU. FT.  *,3X,F8.2,17X,F8.2,/,
    1 6X,*SAMPLE TEMP. DEG. F  *,3X,F8.0,17X,F8.0,/,
    2 6X,*AREA,BUBBLER 1       *,2X,F9.2,16X,F9.2,/,
    3 6X,*DIL. FACT.,BUBBLER 1 *,3X,F8.0,17X,F8.0,/,
    4 6X,*AREA,BUBBLER 2       *,2X,F9.2,16X,F9.2,/,
    5 6X,*DIL. FACT.,BUBBLER 2 *,3X,F8.0,17X,F8.0,/,
    6 6X,*STAND. DEN. MICROG/ML*,3X,F8.2,17X,F8.2,/,
    7 6X,*STAND. AREA,SQ. IN.  *,2X,F9.2,16X,F9.2,/,
    8 6X,*SO2, MILLIG/BUBBLER 1*,3X,F8.3,17X,F8.3,/,
    9 6X,*SO2, MILLIG/BUBBLER 2*,3X,F8.3,17X,F8.3,/,
    A 6X,*SO2, PPM             *,3X,F8.1,17X,F8.1 )
6022 FORMAT(/,5X,*SULFATE AND SO2 EMISSIONS*)
6024 FORMAT(/,6X,*NET SULFATE,MILLIGRAM/TEST      *,  4X,F8.3,/,
    1 6X,*NET H2SO4,MILLIGRAM/TEST        *,4X,F8.3,/,
    2 6X,*NET SO2,GRAM/TEST               *,4X,F8.3,/,
    3 6X,*NET SULFATE,MILLIGRAM/KILOMETRE*,4X,F8.3,/,
    4 6X,*NET H2SO4,MILLIGRAM/KILOMETRE  *,4X,F8.3,/,
    5 6X,*NET SO2,GRAM/KILOMETRE         *,4X,F8.3 )
6026 FORMAT(/,5X,*SULFUR BALANCE*)
6028 FORMAT(6X,*FUEL WT.,*,F5.0,* GRAMS      SULFUR IN FUEL,*,F6.4,
    1 * PCT.*)
6030 FORMAT(32X,*FUEL      SO2       H2SO4      SO2 + H2SO4*,/,
    1        32X,*----      -----     -------     -----------*)
6032 FORMAT(16X,*SULFUR,GRAMS*,4X,F4.2,3X,2X,F5.3,2X,3X,F6.4,4X,5X,
    1 F6.4,/,
    2 16X,*PCT. RECOVERY*,3X,8X,F6.2,2X,3X,F6.2,4X,5X,F6.2)
7000 FORMAT(1H1,///,38X,* TABLE      EXHAUST EMISSIONS SUMMARY, SAN ANTO
    1NIO ROAD ROUTE             *,/,38X,*TRUCK NO. *,A3,*,*,2X,*19*,I2,1X,
    2A10,A5,1X,I4,* CID *,A1,I1,*,*,2X,F5.0,* LB. GVW, *,A10,A5,///,
    31X,*                                                  GRAMS PER MINUTE
    4     GRAMS PER LB OF FUEL           GRAMS PER MILE               *,/,
    51X,*                            RUN DURATION    -----------------------
    6    ---------------------    ---------------------    FUEL WT
    7MILES *,/,
    81X,*   DATE     RUN  DRIVER    MINUTES          HC         CO        NOX
    9     HC          CO         NOX         HC          CO          NOX          LB      P
    1ER GAL *,/,
    21X,* --------  ---  ------  ------------     -----   ------   -----
    3    -----   ------   -----     -----   ------   -----   -------  -
    4--------*,/)
7001 FORMAT(1X,1X,I2,*-*,I2,*-*,I2,2X,I2,4X,A3,6X,F5.2,9X,F5.2,3X,F6.2,
    13X,F5.2,4X,F5.2,3X,F6.2,3X,F5.2,4X,F5.2,3X,F6.2,3X,F5.2,4X,F5.2,
    25X,F4.2)
7002 FORMAT(/,1X, 7X,*OVERALL AVERAGE*,4X,F5.2,9X,F5.2,3X,F6.2,3X,F5.2,
    14X,F5.2,3X,F6.2,3X,F5.2,4X,F5.2,3X,F6.2,3X,F5.2,4X,F5.2,5X,F4.2,/)
7003 FORMAT(1X,4X,*DRIVER *,A3,* AVERAGE*,4X,F5.2,9X,F5.2,3X,F6.2,3X,
    1F5.2,4X,F5.2,3X,F6.2,3X,F5.2,4X,F5.2,3X,F6.2,3X,F5.2,4X,F5.2,5X,
    2F4.2)
C
C         READ INITIAL DATA FOR A TEST
C
      JJ=1
   25 READ 1001,ICN,IUN,ITN,IMO,IDY,IYR,MFC,VMOD,VID,MODYR,IDISP,CYA,
     1NCYL,JTC,AHP,ICWT,GVM
      IF(EOF,60) 999,26
   26 IF(GVM.GE.99999)  GO TO 999
      TGVM = GVM
      JICN = ICN
      IMODYR =MODYR
      JIDISP =IDISP
      TCYA = CYA
     1/,8X,*HC  SAMPLE  PPM*,16X,10X,F5.0,
     2/,8X,*HC  BACKGRD METER READING/SCALE*,10X,F5.1,*/*,I1,
     3/,8X,*HC  BACKGRD PPM*,16X,10X,F5.0,
     4/,8X,*CO  SAMPLE  METER READING/SCALE*,10X,F5.1,*/*,I1,
     5/,8X,*CO  SAMPLE  PPM*,16X,10X,F5.0,
     6/,8X,*CO  BACKGRD METER READING/SCALE*,10X,F8.1,*/*,I1,
     7/,8X,*CO  BACKGRD PPM*,16X,10X,F5.0)
 2005 FORMAT(8X,*CO2 SAMPLE  METER READING/SCALE*,10X,F5.1,*/*,I1,
     1/,8X,*CO2 SAMPLE  PERCENT*,12X,10X,F5.2,
     2/,8X,*CO2 BACKGRD METER READING/SCALE*,10X,F5.1,*/*,I1,
     3/,8X,*CO2 BACKGRD PERCENT*,12X,10X,F5.2,
     4/,8X,*NOX SAMPLE  METER READING/SCALE*,10X,F5.1,*/*,I1,
     5/,8X,*NOX SAMPLE  PPM*,16X,10X,F5.1,
     6/,8X,*NOX BACKGRD METER READING/SCALE*,10X,F8.1,*/*,I1,
     7/,8X,*NOX BACKGRD PPM*,16X,10X,F5.1)
 2006 FORMAT(8X,*HC  CONCENTRATION PPM*,20X,F5.0,
     1/,8X,*CO  CONCENTRATION PPM*,20X,F5.0,
     2/,8X,*CO2 CONCENTRATION PCT*,20X,F5.2,
     3/,8X,*NOX CONCENTRATION PPM*,20X,F5.1,
     4/,8X,*SO2 COCENTRATION PPM*,20X,F5.1,
     5/,8X,*HC  MASS (GRAMS)*,5X,18X,F7.2,
     6/,8X,*CO  MASS (GRAMS)*,5X,18X,F7.2,
     7/,8X,*CO2 MASS (GRAMS)*,5X,17X,F8.2,
     8/,8X,*NOX MASS (GRAMS)*,5X,18X,F7.2,
     9/,8X,*SO2 MASS (GRAMS)*,5X,17X,F8.2)
 2007 FORMAT(/,5X,*HC  GRAMS/KILOMETRE*,4X,F5.2,
     1/,5X,*CO  GRAMS/KILOMETRE*,3X,F6.2,
     2/,5X,*CO2 GRAMS/KILOMETRE*,1X,F5.0,
     3/,5X,*NOX GRAMS/KILOMETRE*,4X,F5.2,
     4/,5X,*SO2 GRAMS/KILOMETRE*,4X,F5.2)
 2008 FORMAT(/,5X,*HC  GRAMS/KG OF FUEL*,2X,F5.2,5X,*HC  GRAMS/MIN*,2X,
     1F7.1,
     2/,5X,*CO  GRAMS/KG OF FUEL*,2X,F5.1,5X,*CO  GRAMS/MIN*,2X,F5.1,
     3/,5X,*CO2 GRAMS/KG OF FUEL*,3X,F5.0,5X,*CO2 GRAMS/MIN*,2X,F5.0,
     4/,5X,*NOX GRAMS/KG OF FUEL*,2X,F5.2,5X,*NOX GRAMS/MIN*,2X,F5.2,
     5/,5X,*SO2 GRAMS/KG OF FUEL*,2X,F5.2,5X,*SO2 GRAMS/MIN*,2X,F5.2)
 2010 FORMAT(8X,*SO2 SAMPLE METER READING/SCALE*,10X,F5.1,*/*I1,
     1/,8X,*SO2 SAMPLE  PPM*,16X,10X,F5.1,
     2/,8X,*SO2 BACKGRD METER READING/SCALE*,10X,F5.1,*/*,I1,
     3/,8X,*SO2 BACKGRD PPM*,16X,10X,F5.1,/,1X)
 2999 FORMAT(1X,* WRONG CVS NUMBER*)
 6000 FORMAT(1X,/  ,5X,*TOTAL CARBON =*,      F8.2,* GRAMS*)
 6002 FORMAT(/,5X,*CARBON BALANCE FUEL CONSUMPTION =*,F6.2,* LITRES PER
     1HUNDRED KILOMETRES*)
 6003 FORMAT(5X,*TOTAL CVS FLOW =*,F8.1,* STD. CU. METRES*)
 6010 FORMAT(/,5X,*DATE *,I2,*/*,I2,*/*,I2,14X,*TIME *,I5,* HRS.*,8X,
     1*TEST NO. *,I2,/,
     25X,*MODEL  19*,I2,1X,2(A10,A5),8X,*ENGINE*,F4.1,* LITRE*,A1,I1,/,
     35X,*BARO. *,F6.1,* MM  HG.*)
 6012 FORMAT(5X,*RUN DURATION *,F7.2,* MIN.  DISTANCE DRIVEN *,F6.2,
     1 * KILOMETRES*,/,
     2 5X,*CVS BLOWER TEST VOL. *,F7.2,* ACT. CU. METRES*)
 6014 FORMAT(/,5X,27X,*SAMPLE *,16X,*BACKGROUND *,/,
     1 5X,*SULFATE DATA *,14X,*------- *,16X,*----------- *)
 6016 FORMAT(/,6X,*FILTER NO.              *,3X,A10,15X,A10,/,
     1 6X,*SAMPLE VOL. CU. FT.  *, 3X,F8.2,17X,F8.2,/,
     2 6X,*SAMPLE TEMP. DEG. F  *, 3X,F8.0,17X,F8.0,/,
     3 6X,*SAMPLE AREA SQ. IN.  *, 2X,F9.2,16X,F9.2,/,
     4 6X,*DILUTION FACTOR      *, 3X,F8.0,17X,F8.0,/,
     5 6X,*STAND. DEN. MICROG/ML*, 3X,F8.2,17X,F8.2,/,
     6 6X,*STAND. AREA SQ. IN.  *, 2X,F9.2,16X,F9.2,/,
     7 6X,*SO4,MICROG/FILTER    *, 3X,F8.3,17X,F8.3)
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DSRMWS,P10,T30,I0100,LS,MFL65000.
ACCOUNT(C62220,SLICK)114874001
CID(HARRY DIETZMANN,2647)
REWIND(DISK1,DISK2)
COPYCR(INPUT,DISK1)
COPYCR(INPUT,DISK2)
REWIND(DISK1,DISK2)
COPYCR(DISK1,OUTPUT)
LIBRARY(RUN2P3)
RUN(S,,,,,,2000)
MAP(PART)
SETCORE(INDEF)
REDUCE.
LGO.
COPYCR(DISK2,OUTPUT)
*
PM       TURN PRINTER PAPER OVER
*
PM       RESTORE PRINTER PAPER
*
      PROGRAM DSRMWS(INPUT,OUTPUT,PUNCH,TAPE60=INPUT)
      INTEGER HCR(2),COR(2),CO2R(2),DRV, SO2R(2),S2C,S3C
      REAL MILES,KO
      DIMENSION ITA(4),ITB(4),ITC(6),ITD(3),VMOD(2),VID(2),EIWT(3),
     1FWT(3),DIF(3),HC(2),PNO(2),CO(2),CO2(2),YH(2), YN(2),YC(2),
     2 YC2(2),HCM(3),PNOM(3),COM(3),BUF(25,3),IBUF(25,7),NOXR(2),
     3ICAN(3),N(3),CO2M(3),CHC(3),CCO(3),CCO2(3),CB(3)
      DIMENSION HCWM(3),COWM(3),CO2WM(3),PNOWM(3),GMHC(3),GMCO(3),
     1GMCO2(3),GMNO(3),GPHC(3),GPCO(3),GPCO2(3),GPNO(3),IARY(12,5),
     2RARY(12,12),SUM(12),AVG(12),DAVG(12),TVMOD(2), TVID(2),SO2(3),
     3        YS2(2),SO2M(3)
      DIMENSION S3STD(2),S3SA(2),S3FA(2),S3DF(2),SML(2),S3VF(2),S3TEM(2)
     1,FILNU(2),S2STD(2),S2SA(2),S2B1A(2),S2B1D(2),S2B2A(2),S2B2D(2),
     2 SAMVOL(2),VOLTEM(2),VOLPRS(2),S3MF(2),S2MB1(2),S2MB2(2),S4MCF(2)
C
 1001 FORMAT(2X,A3,I2,I5,3(I2),A9,1X,2(A10,A5),1X,I2,I4,3X,A1,I1,I2,F4.0
     1,I5,F5.0)
 1004 FORMAT(2X,F7.0,F6.2,2F3.0,I4,2F5.1,2A3,4F5.0,F6.0,I1,1X,I1,I1)
 1005 FORMAT(2X,4(F6.0,I2),I6,F7.0,F6.0,F7.0,4X,F6.0,I2)
 1006 FORMAT(10X,F6.0,2X,F6.0,2X,F6.0,1X,F2.0,2X,F3.0,8X,F6.0,2X,
     1 F4.0,1X,A10)
 1007 FORMAT(10X,F6.0,2X,F6.0,2X,F6.0,1X,F2.0,2X,F6.0,1X,F2.0,2X,
     1 F6.0,2X,F4.0,2X,F4.0)
 2000 FORMAT(1H1,7X,*    TABLE          EXHAUST EMISSIONS FROM SINGLE BAG
     1SAMPLE          *,/,8X,*                          VEHICLE NUMBER *,A3)
 2001 FORMAT( /,5X,*DATE *,I2,*/*,I2,*/*,I2,14X,*TIME *,I5,* HRS.*,8X,
     1*TEST NO. *,I2,/,5X,*MODEL  19*,I2,1X,2(A10,A5),8X,*ENGINE*,F4.1,*
     2 LITRE*,1X,A2,I2,* CYL.*,/,5X,*DRIVER  *,A3,16X,*TEST WT. *,I5,1X,
     3*KG.*,5X,*GVW*,F5.0,1X,*KG *)
 2002 FORMAT(  5X,*WET BULB TEMP *,F3.0,* C         DRY BULB TEMP *,F3.0,
     1* C    REL. HUM.  *,F4.1,* PCT*,/,5X,*SPEC. HUM.  *,F4.1,* GRAM/KG
     2   BARO. * ,F6.1,* MM  HG.   MEASURED FUEL *,F5.2,* KG *,/,
     3 5X,*DISTANCE  *,F6.3,* KM          FUEL *,F5.1,* G/LITRE   FUEL HC
     4 RATIO *,F5.3)
 2003 FORMAT(/,7X,*RUN DURATION *,8X,F5.2,1X,*MINUTES*,/,
     17X,*BLOWER INLET PRESS.*,1X,F5.1,2X,*MM. H2O*,/,
     27X,*BLOWER DIF.  PRESS.*,1X,F5.1,2X,*MM  H2O*,/,
     37X,*BLOWER INLET TEMP. *,1X,  I5,2X*DEG. C*,/,
     67X,*DYNO REVOLUTIONS   *,1X,F5.0,/,
     47X,*BLOWER REVOLUTIONS *,1X,I7,/,
     57X,*BLOWER CU. CM /REV.*,1X,F6.0,//,7X,*BAG RESULTS*)
 2004 FORMAT(8X,*HC  SAMPLE  METER READING/SCALE*,10X,F5.1,*/*,I1,
                   TABLE                        VEHICLE EMISSION RESULTS
                         1975  LIGHT DUTY EMISSIONS TEST'

UNIT NO.  ???         TEST NO. 5        DATE  3/17/77                     MFGR. CODE   -0                    YR. 1976
VEHICLE MODEL  VW RABBIT DIESEL         ENGINE   0.00 LITRE 4 CYL.        TEST WT.  1020 KG                ROAD LOAD    5.4 KW
TEST TYPE  17618874                     COMMENTS  1975 FTP 3 BAG EM-238-F

BAROMETER 733.04 MM OF HG.
DRY BULB TEMP.   25.6 DEG. C                                       WET BULB TEMP  18.9 DEG. C
REL. HUMIDITY     53 PCT.                                           ABS. HUMIDITY  11.3 MILLIGRAMS/KG
EXHAUST EMISSIONS

   BLOWER DIF. PRESS., G2, 457.2 MM. H2O                           BLOWER INLET PRESS., G1 393.7 MM. H2O
                                                                   BLOWER INLET TEMP.    43 DEG. C
   BAG RESULTS
   BAG NO.                                    1            2             3
   BLOWER REVULUTIONS                       9142         15696          9148
   HC    SAMPLE  METER READING/SCALE         1.6/6        10.2/2        12.2/2
   HC    SAMPLE  PPM                          52            20            24
   HC    BACKGRD METER READING/SCALE         5.5/2         5.3/2         4.3/2
   HC    BACKGRD PPM                          11            11             4
   CO    SAMPLE  METER READING/SCALE        54.6/*        25.8/*        35.0/*
   CO    SAMPLE  PPM                          52            24            33
   CO    BACKGRD METER READING/SCALE         1.1/*         1.8/*          .5/*
   CO    BACKGRD PPM                           1             2             0
   CO2   SAMPLE  METER READING/SCALE        47.6/3        29.5/3        41.8/3
   CO2   SAMPLE  PERCENT                     .82           .49           .71
   CO2   BACKGRD METER READING/SCALE        4.0/3         4.3/3         4.1/3
   CO2   BACKGRD PERCENT                     .06           .07           .06
   NOX   SAMPLE  METER READING/SCALE        26.2/2        17.6/2        25.2/2
   NOX   SAMPLE  PPM                        26.2          17.6          25.2
   NOX   BACKGRD METER READING/SCALE         1.0/2         1.1/2          .7/2
   NOX   BACKGRD PPM                         1.0           1.1            .7

   HC    CONCENTRATION PPM                    42            10            16
   CO    CONCENTRATION PPM                    49            22            31
   CO2   CONCENTRATION PCT                   .76           .42           .65
   NOX   CONCENTRATION PPM                  25.3          16.5          24.5
   HC    MASS GRAMS                         1.64           .70           .64
   CO    MASS GRAMS                         3.92          2.98          2.49
   CO2   MASS GRAMS                       959.63        913.15        819.67
   NOX   MASS GRAMS                         3.37          3.78          3.27
    HC    MASS MG                           1.64           .70           .64

   WEIGHTED MASS HC        .15 GRAMS/KILOMETRE
   WEIGHTED MASS CO        .50 GRAMS/KILOMETRE
   WEIGHTED MASS CO2   148.58 GRAMS/KILOMETRE
   WEIGHTED MASS NOX       .59 GRAMS/KILOMETRE

CARBON BALANCE FUEL CONSUMPTION =  5.57 LITRES PER HUNDRED KILOMETRES
TOTAL CVS FLOW =   254.1 STD. CU. METRES
```

```
       TABLE          EXHAUST EMISSIONS FROM SINGLE BAG SAMPLE
                                VEHICLE NUMBER                         4

DATE  3/15/77                   TIME    -0 HRS.          TEST NO.  5
MODEL  1976 VW RABBIT DIES.NYCC                          ENGINE 0.0 LITRE    4 CYL.
DRIVER   DT                     TEST WT.  1020 KG.       GVW    0 KG
WET BULB TEMP  18 C             DRY BULB TEMP  26 C      REL. HUM.  43.8 PCT
SPEC. HUM.   9.5 GRAM/KG        BARO.  740.4 MM  HG.     MEASURED FUEL  0.00 KG
DISTANCE   2.413 KM             FUEL 847.3 G/LITRE   FUEL HC  RATIO 1.844

  RUN DURATION             9.99 MINUTES
  BLOWER INLET PRESS. 393.7  MM. H2O
  BLOWER DIF.  PRESS. 457.2  MM  H2O
  BLOWER INLET TEMP.     43  DEG. C
  DYNO REVOLUTIONS      2720
  BLOWER REVOLUTIONS     10729
  BLOWER CU. CM /REV.  8709

  BAG RESULTS
   HC   SAMPLE  METER READING/SCALE                  22.8/2
   HC   SAMPLE  PPM                                     46
   HC   BACKGRD METER READING/SCALE                  12.0/2
   HC   BACKGRD PPM                                     24
   CO   SAMPLE  METER READING/SCALE                  33.0/4
   CO   SAMPLE  PPM                                     31
   CO   BACKGRD METER READING/SCALE                   9.1/4
   CO   BACKGRD PPM                                      9
   CO2  SAMPLE  METER READING/SCALE                  22.5/3
   CO2  SAMPLE  PERCENT                                .36
   CO2  BACKGRD METER READING/SCALE                   5.1/3
   CO2  BACKGRD PERCENT                                .08
   NOX  SAMPLE  METER READING/SCALE                  13.0/2
   NOX  SAMPLE  PPM                                  13.0
   NOX  BACKGRD METER READING/SCALE                   2.7/2
   NOX  BACKGRD PPM                                   2.7
   HC   CONCENTRATION PPM                              22
   CO   CONCENTRATION PPM                              22
   CO2  CONCENTRATION PCT                             .29
   NOX  CONCENTRATION PPM                            10.4
   SO2  COCENTRATION PPM                             0.0
   HC   MASS (GRAMS)                                 1.04
   CO   MASS (GRAMS)                                 2.06
   CO2  MASS (GRAMS)                               429.10
   NOX  MASS (GRAMS)                                 1.54
   SO2  MASS (GRAMS)                                 0.00

HC   GRAMS/KILOMETRE        .43
CO   GRAMS/KILOMETRE        .85
CO2  GRAMS/KILOMETRE    178
NOX  GRAMS/KILOMETRE        .64
SO2  GRAMS/KILOMETRE      0.00

HC   GRAMS/KG OF FUEL    7.57      HC   GRAMS/MIN       .1
CO   GRAMS/KG OF FUEL    15.0      CO   GRAMS/MIN      .2
CO2  GRAMS/KG OF FUEL    3125      CO2  GRAMS/MIN      43
NOX  GRAMS/KG OF FUEL   11.25      NOX  GRAMS/MIN     .15
SO2  GRAMS/KG OF FUEL    0.00      SO2  GRAMS/MIN    0.00

CARBON BALANCE FUEL CONSUMPTION =  6.71 LITRES PER HUNDRED KILOMETRES
```

Program Description

Program Title DILUTION TUNNEL No. 2 DATA REDUCTION H1B
Name C.T. HARE **Date** 3/1/77
Address
City State Zip Code

Program Description, Equations, Variables, etc.

$$\text{BLOWER MASS / TEST} = 0.4277\,(\text{BLOWER COUNTS})\left(\frac{P_a - P_b/13.6}{\bar{T}_b + 460}\right)\ \text{lb}_m$$

$$\underset{(i=6)}{\text{HI-VOL MASS / TEST}} = 6.518\,(P_a)^{0.517}\sum_{j=1}^{N}\left[\left(\frac{\Delta P_{OR}}{T_{OR}+460}\right)^{0.517}\right]_j \Delta t_j\ \text{lb}_m \quad (\text{SYSTEM } 6)$$

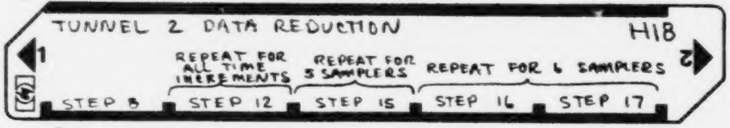
$$\underset{(i=1,\ldots,5)}{\text{OTHER 5 SYSTEMS}}\ (\text{SAMPLE MASS / TEST})_i = (V_2 - V_1)_i\,(1.326)\left(\frac{P_a}{T_a+460}\right)\ \text{lb}_m$$

$$\left(\frac{\text{MASS PARTICULATE EMITTED}}{\text{TEST}}\right)_i = \left(\frac{\text{MASS PARTICULATE ON FILTER}}{\text{SAMPLE MASS}}\right)_i \times \left[\text{BLOWER MASS} + \sum_{i=1}^{6}(\text{SAMPLE MASS})_i\right]$$

Operating Limits and Warnings

DO NOT USE THIS [illegible]

User Instructions



STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
1	LOAD PROGRAM				
2	INITIALIZE		f	CL REG	
3	STORE T_a (ROOM AMBIENT), AVG.	$\bar{T}_a$, °F	STO	D	
4	STORE ROLL COUNTS	ROLL COUNTS	STO	B	
5	STORE TEST TIME	TEST TIME, sec	STO	9	
6	INPUT INTEGRATED BLOWER TEMP.	$\bar{T}_b$, °F	↑		
7	INPUT ATMOSPHERIC PRESSURE, AVG.	$\bar{P}_a$, in Hg	↑		
8	INPUT BLOWER INLET PRESS., in H_2O BELOW ATM.	$\bar{P}_b$, in H_2O	A		
9	INPUT BLOWER COUNTS	BLOWER COUNTS	R/S		BLOWER MASS FOR TEST
10	INPUT TIME INCREMENT j	Δt_j, min	↑		
11	INPUT ORIFICE ΔP FOR TIME INCREMENT j	$(\Delta P_{or})_j$, in H_2O	↑		
12	INPUT ORIFICE TEMP. FOR TIME INCREMENT j	$(T_{or})_j$, °F	B		
	—— REPEAT 10-12 FOR ALL TIME INCREMENTS ——				
13	COMPUTE HI-VOL MASS FOR TEST		R/S		$i = 1$
14	INPUT FINAL DGM VOLUME, SYSTEM i	V_{2i}, ft^3	↑		
15	INPUT INITIAL DGM VOLUME, SYSTEM i	V_{1i}, ft^3	C		NEXT i
	—— REPEAT 14 & 15 FOR $i = 1, \dots, 5$ ——				
					$i = 1$
16	INPUT mg PARTICULATE ON FILTER i, AND				
	COMPUTE (TOT. PART. EMITTED/TEST)$_i$ IN grams	G_i, g	D		(PART./TEST)$_i$ grams
17	COMPUTE (PARTICULATE IN grams/km)$_i$		E		(PARTICULATE)$_i$ grams/km
18	COMPUTE (PARTICULATE IN grams/hr)$_i$,				
	DISPLAY FOR 5 SECONDS		R/S		(PARTICULATE)$_i$ grams/hr
	(AUTOMATIC) CONTINUE PROGRAM				NEXT i
	—— REPEAT 16-18 FOR $i = 1, \dots, 6$ ——				
	—— GO BACK TO STEP 2 FOR NEW TEST ——				7 (END)
	(the following to be recorded only upon request)				

REGISTER	DATA	REGISTER	DATA
B	BLOWER MASS, lb_m	4	(SAMPLE MASS)$_4$, lb_m
1	(SAMPLE MASS)$_1$, lb_m	5	(SAMPLE MASS)$_5$, lb_m
2	(SAMPLE MASS)$_2$, lb_m	6	(SAMPLE MASS)$_6$, lb_m
3	(SAMPLE MASS)$_3$, lb_m		

STEP	KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
001	f LBL A				h ST I		
	1				R/S		
	3				f LBL C		
	.			060	—		
	6				1		
	÷				.		
	h x⇄y				3		
	STO E				2		
	h x⇄y				6		
010	—				×		
	h x⇄y				RCL E		
	4				×		
	6				RCL D		
	0			070	4		
	+				6		
	÷				0		
	.		1.326X CALIBRATED BLOWER ACF/REV FROM PROPANE CK. PROGRAM, $\frac{ACF}{REV} = 0.32253$		+		
	4				÷		
	2				STO (i)		
020	7				h RC I		
	7				1		
	×				+		
	R/S				h ST I		
	×			080	STO A		
	STO B				5		
	R/S				—		
	f LBL B				f x>0		
	4				R/S		
	6				RCL A		
030	0				R/S		
	+				f LBL D		
	÷				1		
	.				0		
	5			090	0		
	1				0		
	7				÷		
	h y^x				h x⇄y		
	×				h ST I		
	STO + 7				h x⇄y		
040	R/S				RCL (i)		
	RCL E				÷		
	.				f GSB 0		
	5				×		
	1			100	STO 0		
	7				R/S		
	h y^x				f LBL E		
	6				RCL B		
	.				1		
	5				4		
050	1				5		
	8				0		
	×				.		
	RCL 7				1		
	×			110	2		
	STO 6				÷		
	1				÷		

REGISTERS

0 tot. part. mass - temporary	1 $(samp. mass)_1$	2 $(samp. mass)_2$	3 $(samp. mass)_3$	4 $(samp. mass)_4$	5 Impactor $(samp. mass)_5$	6 hi-vol $(samp. mass)_6$	7 $\sum_{i=1} \left(\frac{\Delta P_{OR}}{T_{OR}+460}\right)^{.517}$	8 ROLL COUNTS	9 TEST TIME
S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A i (TEMPORARY)	B $\frac{\text{BLOWER MASS}}{\text{TEST}}$	C	D T_a	E P_a	I SAMPLE SYSTEM No. (INDIRECT)

Program Listing

STEP	KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
	R/S						
	RCL 9			170			
	3						
	6						
	0						
	0						
	÷						
120	RCL 0						
	h x≷y						
	÷						
	f -x-						
	h RC I			180			
	1						
	+						
	h RTN						
	f LBL 0						
	RCL 0						
130	RCL 1						
	+						
	RCL 2						
	+						
	RCL 3			190			
	+						
	RCL 4						
	+						
	RCL 5						
	+						
140	RCL 6						
	+						
	h RTN						
				200			
150							
				210			
160							
				220			

LABELS					FLAGS
A STEP 8	B STEP 12	C STEP 15	D STEP 16	E STEP 17	0
a	b	c	d	e	1
0	1	2	3	4	2
5	6	7	8	9	3

SET STATUS		
FLAGS	TRIG	DISP
ON OFF 0 ☐ ☒ 1 ☐ ☒ 2 ☐ ☒ 3 ☐ ☒	DEG ☒ GRAD ☐ RAD ☐	FIX ☒ SCI ☐ ENG ☐ n 6

M238ETPH3

TUNNEL 2 DATA REDUCTION 11-4654-001 KEYED TO HP-67 PROGRAM H18

DATE 4-21-77 TEST No. 2 VEHICLE Mercedes 240-D FUEL EM-238-F

SCHEDULE FTP-H DRIVER DT TUNNEL OP. J.W DATA BY

wet 68 Dry 81

T_a = ROOM AMBIENT TEMPERATURE, °F – BEFORE 81 AFTER 82 AVG. 82 = $\bar{T}_a$

DYNO ROLL COUNTS 17040 TEST TIME, sec 1374 TEMP. INTEG. COUNTS 1870

$\bar{T}_b$ = MEAN BLOWER TEMP. °F [READ FROM TABLE VIII, $m_v = 1.44\left(\frac{\text{INTEG. COUNTS}}{\text{TEST TIME}}\right)$] 101

P_a = ATMOSPHERIC PRESSURE, in Hg – BEFORE 29.20 AFTER 29.20 AVG. 29.20 = $\bar{P}_a$

j = TIME INCREMENT	TIME AT END, sec.	Δt_j = DURATION min.	$(\Delta p_{OR})_j$, in H_2O	$(T_{OR})_j$, °F	$(p_b)_j$, in H_2O
1	180	3	1.33	90	7.5
2	360		1.33	100	7.7
3	540		1.33	110	7.6
4	720		1.33	114	7.6
5	900		1.33	120	7.5
6	1080		1.33	127	7.7
7	1260		1.33	131	7.7
8	1374	1.90	1.33	132	7.7
9					
10					
				$\bar{P}_b$ = AVERAGE =	7.63

IMPACTOR SET No. 35 219-1

STAGE	DISC NUMBER	mg PARTICULATE
1	1	0.031
2	2	0.021
3	3	0.081
4	4	0.185
5	5	0.108
6	6	0.153
7	7	0.173
8	8	0.220
FILTER	F	4.471
TOTAL SAMPLE mg		5.443

0.972

BLOWER COUNTS 37542

* SAMPLE SYSTEM	DRY GAS METER VOLUME, ft3 BEFORE	AFTER	mg PARTICULATE ON FILTER	TOTAL PARTICULATE EMITTED g/TEST	g/km	g/hr	FILTER NUMBER
1	00.000	10.162	2.312	2.742	0.233	7.184	FH47-8021
2	00.000	10.111	2.001	2.385	0.203	6.249	FH47-8022
3	00.000	10.034	3.090	3.711	0.316	9.724	A47-8067
4	00.000	10.385	3.072	3.579	0.305	9.377	A47-8068
5	49.552	68.263	(FILTER + DISCS) 5.443	3.513	0.299	9.205	SEE ABOVE
6	—	—	144.309	3.351	0.285	8.781	AR-8033

* 1 & 2 are 47-mm fluoropores, 3 & 4 are 47-mm glass fiber, 5 is impactor, 6 is hi-vol

Background FH47 – 8093 00.000 12.670

RECORD ONLY UPON REQUEST (ALL IN lbm/test)

REG.	DATA	VALUE	REG.	DATA	VALUE
B	BLWR. MASS	819.65	4	SAMP. MASS 4	0.739
1	SAMP. MASS 1	0.726	5	SAMP. MASS 5	1.334
2	SAMP. MASS 2	0.722	6	SAMP. MASS 6	37.07
3	SAMP. MASS 3	0.717			

Isokinetic flow check

$m_1 \rightarrow m_4 = (8.774 \times 10^{-4})B$

$m_5 = (1.514 \times 10^{-3})B$

$m_6 = (4.567 \times 10^{-2})B$

TEM MICROGRAPH DATA REDUCTION

Sheet by____________________Project____________________Date____________________
micrograph no.______________magnification______________disc no.______________
vehicle____________fuel____________test type____________test date____________

agglom. no.	size less than (μm)	
	circle	line
1		
2		
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agglom. no.	size less than (μm)	
	circle	line
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agglom. no.	size less than (μm)	
	circle	line
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TEM MICROGRAPH DATA SUMMARY

size less than (µm)	number of agglomerates by micrograph no. and sizing criterion											
	circle	line	circle	line	circle	line	circle	line	circle	line	circle	line
(particle)												
0.02												
0.05												
0.10												
0.15												
0.20												
0.30												
0.40												
0.50												
0.60												
0.80												
1.0												

size less than (µm)	percent of agglomerates by micrograph no. and sizing criterion											
	circle	line	circle	line	circle	line	circle	line	circle	line	circle	line
(particle)												
0.02												
0.05												
0.10												
0.15												
0.20												
0.30												
0.40												
0.50												
0.60												
0.80												
1.0												

APPENDIX F

GASEOUS EMISSIONS AND ODOR DATA

MERCEDES 240D GASEOUS EMISSIONS - DISTANCE BASIS

	VAR. 40 HC G/KM	VAR. 41 CO G/KM	VAR. 42 NOX G/KM	VAR. 43 CO2 G/KM	VAR. 44 FUEL L/100 KM	VAR. 45 FORMALDE MG/KM	VAR. 46 ACETALDE MG/KM	VAR. 47[a] ACETONE MG/KM	VAR. 48 ISOBUTYR MG/KM	VAR. 49 CROTONAL MG/KM	VAR. 50 HEXANAL MG/KM	VAR. 51 BENZALDE MG/KM	VAR. 52[b] O-CRESOL MG/KM	VAR. 53 P-CRESOL MG/KM
FUEL 238														
FTP 3BAG	.1200	.5700	.7800	226.0000	8.4800	4.7000	1.0000	3.6000	.5600	4.0000	.7500	2.2000		
FTP C	.1400	.6000	.8100	236.0000	8.8300	6.0000	.9100	2.6000	.7400	4.6000	.8400	2.8000		
FTP H	.0900	.5400	.7300	211.0000	7.9000	3.8000	1.1000	4.3000	.4200	3.6000	.6800	1.8000		
CFDS	.0900	.3900	.8400	188.0000	7.0300	2.2000	.3400	.7800	.6700	1.1000	.3100	2.9000		
FET	.0600	.3500	.6800	172.0000	6.4300	.8600	.2900	2.0000	.1100	2.0000	.1300	3.0000		
NYCC	.2673	1.1075	1.1712	353.8940	13.2392	11.7116	3.1825	36.9170	3.6917	24.1870	2.2914	0.0000		
IDLE[c]	2.2200	6.6300	5.8800	1630.0000	.6160	66.0000	3.6000	54.0000	5.4000	114.0000	90.0000	0.0000	0.0000	0.0000
50 KPH	.0800	.2700	.4700	124.0000	4.6400	1.1000	.1500	.8200	.4300	3.2000	.2700	1.2000	0.0000	0.0000
85 KPH	.0800	.3600	.8400	172.0000	6.4400	1.4000	.0840	.5800	.2500	1.6000	.4600	.4800	.0320	.0300
FUEL 239														
FTP 3BAG	.1900	.6400	.7900	230.0000	8.6000	5.0000	.6900	3.1000	.6000	3.7000	1.2000	0.0000		
FTP C	.2100	.6600	.8100	242.0000	9.0400	5.7000	.6700	.4700	0.0000	3.7000	2.0000	0.0000		
FTP H	.1300	.6000	.8000	217.0000	8.1100	4.6000	.7000	6.7000	1.4000	3.7000	.6300	0.0000		
CFDS	.0800	.4500	.7200	194.0000	7.2400	1.9000	0.0000	0.0000	0.0000	11.5000	.4200	0.0000		
FET	.0600	.4000	.7300	175.0000	6.5300	3.3000	0.0000	1.1000	6.8000	2.8000	1.4000	1.3000		
NYCC	.2673	1.3112	1.2730	381.9000	14.2576	5.0920	0.0000	0.0000	29.2790	19.0950	0.0000	0.0000		
IDLE[c]	2.1000	6.1800	5.7000	1530.0000	.5780	0.0000	0.0000	0.0000	0.0000	108.0000	49.8000	0.0000	0.0000	0.0000
50 KPH	.0600	.2700	.5000	132.0000	4.9500	0.0000	0.0000	0.0000	0.0000	1.4000	.5600	0.0000	0.0000	.0100
85 KPH	.0600	.4100	.7700	175.0000	6.5600	.5300	0.0000	0.0000	0.0000	1.1000	0.0000	0.0000	.0260	.0240
FUEL 240														
FTP 3BAG	.0900	.5700	.7300	228.0000	8.5100	2.5000	.0870	.3100	2.9000	3.9000	1.3000	5.1000		
FTP C	.1000	.5800	.7400	238.0000	8.9000	2.6000	.1400	.7300	1.4000	4.1000	1.8000	5.1000		
FTP H	.0900	.5800	.7200	215.0000	8.0400	2.4000	.0470	0.0000	4.0000	3.8000	1.0000	5.1000		
CFDS	.0600	.4500	.6900	201.0000	7.5200	2.9000	.4600	1.2000	.5900	4.0000	.5300	.9800		
FET	.0400	.4100	.6900	188.0000	7.0100	3.7000	.6100	1.4000	.4400	16.0000	.4100	1.0000		
NYCC	.1528	1.3239	1.3366	400.9950	15.0214	.4837	0.0000	7.3834	1.9095	17.8220	0.0000	3.6917		
IDLE[c]	1.3800	6.1200	6.4800	1820.0000	.6850	0.0000	0.0000	37.8000	10.8000	86.4000	13.8000	21.6000	0.0000	.3800
50 KPH	.0400	.2500	.4100	119.0000	4.4300	.8300	0.0000	.7600	.2200	1.5200	1.1000	.7200	0.0000	.0096
85 KPH	.0500	.4000	.7000	181.0000	6.7600	.8800	.0900	.3200	0.0000	.9900	.3900	.4900	0.0000	.0210
FUEL 241														
FTP 3BAG	.2000	.7100	.8800	250.0000	9.3800	7.0000	1.3000	2.6000	1.2000	3.7000	2.1000	6.0000		
FTP C	.2400	.7500	.8900	260.0000	9.7400	6.7000	1.1000	1.6000	1.2000	3.5000	2.3000	4.5000		
FTP H	.1500	.6800	.8500	237.0000	8.8800	7.2000	1.4000	3.3000	1.2000	3.8000	1.9000	7.1000		
CFDS	.0800	.4800	.8300	210.0000	7.8600	1.1000	.4100	1.9000	.4200	14.0000	.2100	1.1000		
FET	.0500	.4000	.8000	188.0000	7.0300	1.2000	0.0000	.7500	.2200	.5400	.2700	5.1000		
NYCC	.3310	1.5531	1.4003	409.9060	15.4033	0.0000	0.0000	4.8374	2.8006	14.0030	3.5644	14.0030		
IDLE[c]	2.9700	7.5900	7.4700	1740.0000	.6550	49.8000	7.8000	60.0000	16.8000	60.0000	13.8000	43.2000	0.0000	.5200
50 KPH	.0600	.3000	.4900	131.0030	4.9100	0.0000	0.0000	.0900	.3300	1.4000	.2700	2.6000	0.0000	.0210
85 KPH	.0600	.4000	.7000	184.0000	6.8600	.8400	0.0000	.3200	.1900	1.6000	.1600	.4000	0.0000	.0260
FUEL 242														
FTP 3BAG	.1200	.6800	.8500	251.0000	9.3800	5.4000	.5700	1.2000	4.2000	3.4000	2.2000	.0800		
FTP C	.1400	.7100	.8700	263.0000	9.8300	5.0000	0.0000	.3200	4.7000	2.6000	1.2000	0.0000		
FTP H	.1000	.6500	.8200	233.0000	8.7100	5.7000	1.0000	1.9000	3.8000	4.0000	2.9000	.1400		
CFDS	.0700	.4500	.7100	183.0000	6.8500	1.2000	0.0000	0.0000	3.9000	1.1000	1.2000	0.0000		
FET	.0500	.4100	.6900	173.0000	6.4800	1.1000	0.0000	0.0000	6.4000	.8800	.3400	0.0000		
NYCC	.2037	1.2475	1.2348	348.8020	13.1119	3.1825	0.0000	0.0000	44.5550	4.7101	0.0000	0.0000		
IDLE[c]	1.3800	5.9400	5.6100	1510.0000	.5670	37.8000	0.0000	0.0000	288.0000	57.0000	44.4000	0.0000	0.0000	0.0000
50 KPH	.0600	.2500	.4500	124.0000	4.6400	.9800	0.0000	0.0000	4.8000	1.1000	0.0000	0.0000	0.0000	0.0000
85 KPH	.0500	.4000	.6800	159.0000	5.9600	1.4000	0.0000	0.0000	1.7000	.2500	0.0000	0.0000	.0170	.0280

[a] plus acrolein and propanal
[b] plus salicylaldehyde
[c] idle emissions per hour(/h) rather than per kilometer (/km)

MERCEDES 240D GASEOUS EMISSIONS - DISTANCE BASIS

	VAR. 54[a] 2,4-XYL MG/KM	VAR. 55[b] 2,3-XYL MG/KM
FUEL 238		
FTP 3BAG		
FTP C		
FTP H		
CFDS		
FET		
NYCC		
IDLE[c]	0.0000	0.0000
50 KPH	0.0000	0.0000
85 KPH	0.0000	0.0000
FUEL 239		
FTP 3BAG		
FTP C		
FTP H		
CFDS		
FET		
NYCC		
IDLE[c]	0.0000	0.0000
50 KPH	0.0000	0.0000
85 KPH	0.0000	0.0000
FUEL 240		
FTP 3BAG		
FTP C		
FTP H		
CFDS		
FET		
NYCC		
IDLE[c]	0.0000	0.0000
50 KPH	0.0000	0.0000
85 KPH	0.0000	0.0000
FUEL 241		
FTP 3BAG		
FTP C		
FTP H		
CFDS		
FET		
NYCC		
IDLE[c]	0.0000	0.0000
50 KPH	0.0000	0.0000
85 KPH	0.0000	0.0000
FUEL 242		
FTP 3BAG		
FTP C		
FTP H		
CFDS		
FET		
NYCC		
IDLE[c]	0.0000	0.0000
50 KPH	0.0000	0.0000
85 KPH	0.0000	0.0000

[a] plus 2,5-xylenol
[b] plus 3,5-xylenol
[c] idle emissions per hour (/h) rather than per kilometer (/km)

VW RABBIT DIESEL GASEOUS EMISSIONS - DISTANCE BASIS

	VAR. 40 HC G/KM	VAR. 41 CO G/KM	VAR. 42 NOX G/KM	VAR. 43 CO2 G/KM	VAR. 44 FUEL L/100 KM	VAR. 45 FORMALDE MG/KM	VAR. 46 ACETALDE MG/KM	VAR. 47[a] ACETONE MG/KM	VAR. 48 ISOBUTYR MG/KM	VAR. 49 CROTONAL MG/KM	VAR. 50 HEXANAL MG/KM	VAR. 51 BENZALDE MG/KM	VAR. 52[b] O-CRESOL MG/KM	VAR. 53 P-CRESOL MG/KM
FUEL 238														
FTP 3BAG	.1800	.4900	.5900	153.0000	5.7100	6.0000	1.2000	5.5000	.7300	6.1000	3.9000	5.3000		
FTP C	.2300	.5500	.6200	158.0000	5.9500	6.4000	1.5000	6.5000	.8200	6.8000	4.6000	7.9000		
FTP H	.1600	.4500	.5600	145.0000	5.4400	5.7000	.9000	4.8000	.6700	5.5000	3.2000	3.3000		
CFDS	.0800	.3600	.5300	127.0000	4.7400	3.8000	.8200	2.5000	17.0000	17.0000	21.0000	21.0000		
FET	.1100	.3200	.5300	116.0000	4.3500	2.9000	.1500	2.0000	.6500	2.6000	.9500	3.7000		
NYCC	.5474	1.0821	.8147	226.5940	8.5418	24.1870	1.2730	14.0030	10.4366	29.2790	7.1288	7.3834		
IDLE [c]	7.3800	14.4000	4.6500	1110.0000	.4320	204.0000	42.0000	132.0000	30.0000	144.0000	42.0000	270.0000	0.0000	.3500
50 KPH	.1000	.2700	.3100	92.0000	3.4400	5.2000	.6700	5.3000	.5400	2.4000	.5400	5.6000	.0260	.0530
85 KPH	.0800	.3300	.5500	119.0000	4.4500	1.9000	.2600	1.5000	1.6000	1.2000	.3200	1.6000	.0350	.0360
FUEL 239														
FTP 3BAG	.2000	.5100	.6500	150.0000	5.6000	5.1000	.3900	1.1000	1.3000	3.7000	.8400	.2800		
FTP C	.2800	.5700	.6500	158.0000	5.9100	6.2000	.9000	2.0000	1.2000	4.6000	1.3000	0.0000		
FTP H	.1400	.4500	.5900	139.0000	5.2000	4.3000	0.0000	.4300	1.3000	3.0000	.5000	.5000		
CFDS	.1200	.4200	.5000	131.0000	4.9200	1.1000	0.0000	.2400	0.0000	27.1000	3.3000	0.0000		
FET	.1000	.3800	.5700	121.0000	4.5200	2.2000	0.0000	0.0000	0.0000	8.1000	.7900	0.0000		
NYCC	.3946	1.1584	.9802	227.8670	8.5800	8.7837	0.0000	0.0000	7.8926	59.8310	0.0000	0.0000		
IDLE [c]	6.4800	12.5000	4.8900	1090.0000	.4210	378.0000	0.0000	0.0000	384.0000	408.0000	0.0000	0.0000	0.0000	.2200
50 KPH	.0700	.2300	.3400	95.0000	3.5500	1.7000	0.0000	0.0000	0.0000	4.9000	1.1000	0.0000	0.0000	.0230
85 KPH	.1000	.3600	.5700	117.0000	4.3800	1.4000	.1100	.8900	1.1000	1.3000	0.0000	0.0000	.0270	0.0000
FUEL 240														
FTP 3BAG	.1700	.5500	.5700	152.0000	5.7100	4.0000	.4100	.4600	1.2000	3.1000	2.9000	5.7000		
FTP C	.2400	.5800	.5800	160.0000	6.0000	4.6000	.7000	.6300	1.3000	3.6000	3.6000	3.2000		
FTP H	.1500	.5400	.5600	146.0000	5.4800	3.6000	.1900	.3300	1.2000	2.7000	2.4000	7.6000		
CFDS	.1200	.4200	.5100	130.0000	4.8700	3.4000	.2900	.3600	.3400	2.7000	2.5000	5.6000		
FET	.1500	.4600	.4800	121.0000	4.5500	2.2000	.2300	.5700	.7800	1.1000	0.0000	4.2000		
NYCC	.3310	1.1839	.7893	224.0480	8.4400	12.7300	2.0368	0.0000	0.0000	10.4366	4.8374	5.0920		
IDLE [c]	3.6000	10.6000	5.7300	1190.0000	.4560	132.0000	7.8000	14.4000	16.8000	84.0000	14.4000	144.0000	0.0000	.6700
50 KPH	.0500	.2900	.3100	91.0000	3.4000	1.8000	.3800	.9400	1.3000	4.4000	.2700	.4300	.0074	.0230
85 KPH	.1300	.4600	.8400	119.0000	4.4700	2.2000	.4000	.4500	.3300	.5100	0.0000	2.4000	.0630	.0710
FUEL 241														
FTP 3BAG	.7100	.8100	.5800	162.0000	6.1700	19.0000	4.8000	8.4000	2.3000	6.2000	3.9000	7.8000		
FTP C	1.1200	.9300	.5900	168.0000	6.4500	23.0000	6.0000	11.0000	2.2000	6.5000	3.4000	13.0000		
FTP H	.3600	.7000	.5800	150.0000	5.6500	16.0000	3.4000	6.5000	2.3000	6.0000	4.3000	3.9000		
CFDS	.2000	.4300	.5700	134.0000	5.0200	3.8000	.4500	.9100	.6600	1.6000	.5100	2.1000		
FET	.1500	.3400	.5200	123.0000	4.6100	1.4000	.2200	.6500	0.0000	1.9000	.4100	5.2000		
NYCC	1.3494	1.8968	.8911	240.5970	9.2292	11.2024	0.0000	2.5460	1.9095	12.4754	7.3834	17.8220		
IDLE [c]	17.5000	28.0000	5.5200	1310.0000	.5270	384.0000	96.0000	90.0000	55.2000	132.0000	20.4000	162.0000	0.0000	6.7000
50 KPH	1.0600	.9200	.3000	94.0000	3.6800	20.0000	4.4000	3.3000	1.3000	3.7000	1.1000	3.8000	.1000	.2700
85 KPH	.2000	.3300	.5300	120.0000	4.5100	3.3000	.5700	.8700	1.2000	1.2000	.2400	1.4000	.0870	.2100
FUEL 242														
FTP 3BAG	.2000	.5200	.6300	157.0000	5.8900	6.2000	.8600	1.6000	1.8000	2.1000	1.0000	0.0000		
FTP C	.2600	.5700	.6300	162.0000	6.0700	8.1000	2.0000	2.4000	1.9000	2.7000	.6400	0.0000		
FTP H	.1400	.4800	.6400	157.0000	5.8800	4.7000	0.0000	.9300	1.7000	1.7000	1.3000	0.0000		
CFDS	.1000	.3800	.5700	136.0000	5.0900	1.8000	0.0000	0.0000	.1000	.0100	0.0000	0.0000		
FET	.1100	.3900	.5800	126.0000	4.7100	1.3000	0.0000	0.0000	3.8000	1.7000	1.3000	0.0000		
NYCC	.3692	.9548	.8911	231.6860	8.6946	3.9463	0.0000	0.0000	44.5550	14.0030	12.7300	0.0000		
IDLE	6.3900	11.9000	4.7700	1120.0000	.4320	276.0000	102.0000	138.0000	282.0000	114.0000	57.0000	0.0000	0.0000	.5400
50 KPH	.0700	.1900	.3800	95.0000	3.5400	3.3000	.2400	1.3000	.8900	1.4000	.8900	.6400	0.0000	.0110
85 KPH	.0800	.3500	.6000	121.0000	4.5400	1.5000	0.0000	.3100	1.8000	1.8000	0.0000	0.0000	.0380	.0480

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[a] plus 2,5-xylenol
[b] plus 3,5-xylenol
[c] idle emissions per hour (/h) rather than per kilometer (/km)

VW RABBIT DIESEL GASEOUS EMISSIONS - DISTANCE BASIS

	VAR. 54[a] 2,4-XYL MG/KM	VAR. 55[b] 2,3-XYL MG/KM
FUEL 238		
FTP 38AG		
FTP C		
FTP H		
CFDS		
FET		
NYCC		
IDLE[c]	0.0000	0.0000
50 KPH	0.0000	.0140
85 KPH	0.0000	0.0000
FUEL 239		
FTP 38AG		
FTP C		
FTP H		
CFDS		
FET		
NYCC		
IDLE[c]	0.0000	0.0000
50 KPH	0.0000	0.0000
85 KPH	0.0000	0.0000
FUEL 240		
FTP 38AG		
FTP C		
FTP H		
CFDS		
FET		
NYCC		
IDLE[c]	0.0000	0.0000
50 KPH	0.0000	.0074
85 KPH	0.0000	0.0000
FUEL 241		
FTP 38AG		
FTP C		
FTP H		
CFDS		
FET		
NYCC		
IDLE[c]	.1600	6.7000
50 KPH	.0037	.1600
85 KPH	0.0000	.0780
FUEL 242		
FTP 38AG		
FTP C		
FTP H		
CFDS		
FET		
NYCC		
IDLE[c]	0.0000	0.0000
50 KPH	0.0000	0.0000
85 KPH	0.0000	0.0000

[a] plus 2,5-xylenol
[b] plus 3,5-xylenol
[c] idle emissions per hour (/h) rather than per kilometer (/km)

MERCEDES 240D GASEOUS EMISSIONS - TIME BASIS

	VAR. 40 HC G/HR	VAR. 41 CO G/HR	VAR. 42 NOX G/HR	VAR. 43 CO2 KG/HR	VAR. 44 FUEL L/HR	VAR. 45 FORMALDE MG/HR	VAR. 46 ACETALDE MG/HR	VAR. 47[a] ACETONE MG/HR	VAR. 48 ISOBUTYR MG/HR	VAR. 49 CROTONAL MG/HR	VAR. 50 HEXANAL MG/HR	VAR. 51 BENZALDE MG/HR	VAR. 52[b] O-CRESOL MG/HR	VAR. 53 P-CRESOL MG/HR
FUEL 238														
FTP 3BAG	3.7752	17.9322	24.5388	7.1100	2.6678	147.8620	31.4600	113.2560	17.6176	125.8400	23.5950	69.2120		
FTP C	4.4044	18.8760	25.4826	7.4246	2.7779	188.7600	28.6286	81.7960	23.2804	144.7160	26.4264	88.0880		
FTP H	2.8314	16.9884	22.9658	6.6381	2.4853	119.5480	34.6060	135.2780	13.2132	113.2560	21.3928	56.6280		
CFDS	5.0346	21.8166	46.9896	10.5167	3.9326	123.0680	19.0196	43.6332	37.4798	61.5340	17.3414	162.2260		
FET	4.6512	27.1320	52.7136	13.3334	4.9845	66.6672	22.4808	155.0400	8.5272	155.0400	10.0776	232.5600		
NYCC	3.0395	12.5924	13.3161	4.0238	1.5053	133.1609	36.1850	419.7463	41.9746	275.0062	26.0532	0.0000		
IDLE	2.2200	6.6300	5.8800	1.6300	.6160	66.0000	3.6000	54.0000	5.4000	114.0000	90.0000	0.0000	0.0000	0.0000
50 KPH	4.0000	13.5000	23.5000	6.2000	2.3200	55.0000	7.5000	41.0000	21.5000	160.0000	13.5000	60.0000	0.0000	0.0000
85 KPH	6.8000	30.6000	71.4000	14.6200	5.4740	119.0000	7.1400	49.3000	21.2500	136.0000	39.1000	40.8000	2.7200	2.5500
FUEL 239														
FTP 3BAG	5.9774	20.1344	24.8534	7.2358	2.7056	157.3000	21.7074	97.5260	18.8760	116.4020	37.7520	0.0000		
FTP C	6.6066	20.7636	25.4826	7.6133	2.8440	179.3220	21.0782	14.7862	0.0000	116.4020	62.9200	0.0000		
FTP H	4.0898	18.8760	25.1680	6.8268	2.5514	144.7160	22.0220	210.7820	44.0440	116.4020	19.6148	0.0000		
CFDS	4.4752	25.1730	40.2768	10.8524	4.0501	106.2880	0.0000	0.0000	0.0000	643.3100	23.4948	0.0000		
FET	4.6512	31.0080	56.5896	13.5660	5.0621	255.8160	0.0000	85.2720	527.1360	217.0560	108.5280	100.7760		
NYCC	3.0395	14.9082	14.4740	4.3422	1.6211	57.8960	0.0000	0.0000	332.9022	217.1101	0.0000	0.0000		
IDLE	2.1000	6.1800	5.7000	1.5300	.5780	0.0000	0.0000	0.0000	0.0000	108.0000	49.8000	0.0000	0.0000	0.0000
50 KPH	3.0000	13.5000	25.0000	6.6000	2.4750	0.0000	0.0000	0.0000	0.0000	70.0000	28.0000	0.0000	0.0000	.5000
85 KPH	5.1000	34.8500	65.4500	14.8750	5.5760	45.0500	0.0000	0.0000	0.0000	93.5000	0.0000	0.0000	2.2100	2.0400
FUEL 240														
FTP 3BAG	2.8314	17.9322	22.9658	7.1729	2.6772	78.6500	2.7370	9.7526	91.2340	122.6940	40.8980	160.4460		
FTP C	3.1460	18.2468	23.2804	7.4875	2.7999	81.7460	4.4044	22.9658	44.0440	128.9860	56.6280	160.4460		
FTP H	2.8314	18.2468	22.6512	6.7639	2.5294	75.5040	1.4786	0.0000	125.8400	119.5480	31.4600	160.4460		
CFDS	3.3564	25.1730	38.5986	11.2439	4.2067	162.2260	25.7324	67.1280	33.0046	223.7600	24.6482	54.8212		
FET	3.1008	31.7832	53.4888	14.5738	5.4342	286.8240	47.2872	108.5280	34.1088	1240.3200	31.7832	77.5200		
NYCC	1.7369	15.0530	15.1977	4.5593	1.7079	5.5001	0.0000	83.9493	21.7110	202.6361	0.0000	41.9746		
IDLE	1.3800	6.1200	6.4800	1.8200	.6850	0.0000	0.0000	37.8000	10.8000	86.4000	13.8000	21.6000	0.0000	.3800
50 KPH	2.0000	12.5000	20.5000	5.9500	2.2150	41.5000	0.0000	38.0000	11.0000	76.0000	55.0000	36.0000	0.0000	.4800
85 KPH	4.2500	34.0000	59.5000	15.3850	5.7460	74.8000	7.6500	27.2000	0.0000	84.1500	33.1500	41.6500	0.0000	1.7850
FUEL 241														
FTP 3BAG	6.2920	22.3366	27.6848	7.8650	2.9509	220.2200	40.8980	81.7960	37.7520	116.4020	66.0660	188.7600		
FTP C	7.5504	23.5950	27.9994	8.1796	3.0642	210.7820	34.6060	50.3360	37.7520	110.1100	72.3560	141.5700		
FTP H	4.7190	21.3928	26.7410	7.4560	2.7936	226.5120	44.0440	103.8180	37.7520	119.5480	59.7740	223.3660		
CFDS	4.4752	26.8512	46.4302	11.7474	4.3969	61.5340	22.9354	106.2860	23.4948	783.1600	11.7474	61.5340		
FET	3.8760	31.0080	62.0160	14.5738	5.4497	93.0240	0.0000	58.1400	17.0544	41.8608	20.9304	395.3520		
NYCC	3.7632	17.6583	15.4214	4.6606	1.7514	0.0000	0.0000	55.0012	31.8428	159.2141	40.5272	159.2141		
IDLE	2.9700	7.5900	7.4700	1.7400	.6550	49.8000	7.8000	60.0000	16.8000	60.0000	13.6000	43.2000	0.0000	.5200
50 KPH	3.0000	15.0000	24.5000	6.5500	2.4550	0.0000	0.0000	4.5000	16.5000	70.0000	13.5000	130.0000	0.0000	1.0500
85 KPH	5.1000	34.0000	59.5000	15.6400	5.8310	71.4000	0.0000	27.2000	16.1500	136.0000	13.6000	34.0000	0.0000	2.2100
FUEL 242														
FTP 3BAG	3.7752	21.3928	26.7410	7.8965	2.9509	169.8840	17.9322	37.7520	132.1320	106.9640	69.2120	2.5166		
FTP C	4.4044	22.3366	27.3702	8.2740	3.0925	157.3000	0.0000	10.0672	147.8620	81.7960	37.7520	0.0000		
FTP H	3.1460	20.4490	25.7972	7.3302	2.7402	179.3220	31.4600	59.7740	119.5480	125.8400	91.2340	4.4044		
CFDS	3.9158	25.1730	39.7174	10.2370	3.8319	67.1280	0.0000	0.0000	218.1660	61.5340	67.1280	0.0000		
FET	3.8760	31.7832	53.4888	13.4110	5.0233	85.2720	0.0000	0.0000	496.1280	68.2176	26.3568	0.0000		
NYCC	2.3158	14.1845	14.0398	3.9659	1.4908	36.1850	0.0000	0.0000	506.5904	53.5538	0.0000	0.0000		
IDLE	1.3800	5.9400	5.6100	1.5100	.5670	37.8000	0.0000	0.0000	288.0000	57.0000	44.4000	0.0000	0.0000	0.0000
50 KPH	3.0000	12.5000	22.5000	6.2000	2.3200	49.0000	0.0000	0.0000	240.0000	55.0000	0.0000	0.0000	0.0000	0.0000
85 KPH	4.2500	34.0000	57.8000	13.5150	5.0660	119.0000	0.0000	0.0000	144.5000	21.2500	0.0000	0.0000	1.4450	2.3800

[a] plus acrolein and propanal

[b] plus salicylaldehyde

MERCEDES 240D GASEOUS EMISSIONS - TIME BASIS

```
           VAR. 54a VAR. 55b
            2,4-XYL  2,3-XYL
              MG/HR    MG/HR
           -------- --------

FUEL 238
 FTP 3BAG
 FTP C
 FTP H
 CFDS
 FET
 NYCC
 IDLE        0.0000   0.0000
 50 KPH      0.0000   0.0000
 85 KPH      0.0000   0.0000

FUEL 239
 FTP 3BAG
 FTP C
 FTP H
 CFDS
 FET
 NYCC
 IDLE        0.0000   0.0000
 50 KPH      0.0000   0.0000
 85 KPH      0.0000   0.0000

FUEL 240
 FTP 3BAG
 FTP C
 FTP H
 CFDS
 FET
 NYCC
 IDLE        0.0000   0.0000
 50 KPH      0.0000   0.0000
 85 KPH      0.0000   0.0000

FUEL 241
 FTP 3BAG
 FTP C
 FTP H
 CFDS
 FET
 NYCC
 IDLE        0.0000   0.0000
 50 KPH      0.0000   0.0000
 85 KPH      0.0000   0.0000

FUEL 242
 FTP 3BAG
 FTP C
 FTP H
 CFDS
 FET
 NYCC
 IDLE        0.0000   0.0000
 50 KPH      0.0000   0.0000
 85 KPH      0.0000   0.0000
```

[a] plus 2,5-xylenol
[b] plus 3,5-xylenol

VW RABBIT DIESEL GASEOUS EMISSIONS - TIME BASIS

	VAR. 40 HC G/HR	VAR. 41 CO G/HR	VAR. 42 NOX G/HR	VAR. 43 CO2 KG/HR	VAR. 44 FUEL L/HR	VAR. 45 FORMALDE MG/HR	VAR. 46 ACETALDE MG/HR	VAR. 47[a] ACETONE MG/HR	VAR. 48 ISOBUTYR MG/HR	VAR. 49 CROTONAL MG/HR	VAR. 50 HEXANAL MG/HR	VAR. 51 BENZALDE MG/HR	VAR. 52[b] O-CRESOL MG/HR	VAR. 53 P-CRESOL MG/HR
FUEL 238														
FTP 3BAG	5.6628	15.4154	18.5614	4.8134	1.7964	188.7600	37.7520	173.0300	22.9656	191.9060	122.6940	166.7380		
FTP C	7.2358	17.3030	19.5052	4.9707	1.8719	201.3440	47.1900	204.4900	25.7972	213.9280	151.0080	248.5440		
FTP H	5.0336	14.1570	17.6176	4.5617	1.7114	179.3220	28.3140	151.0080	21.0782	173.0300	100.6720	103.8180		
CFDS	4.4752	20.1384	29.6482	7.1044	2.6516	212.5720	45.8708	139.8500	950.9800	950.9800	1174.7400	1174.7400		
FET	8.5272	24.8064	41.0856	8.9923	3.3721	224.8080	11.6280	155.0400	50.3880	201.5520	73.6440	286.8240		
NYCC	6.2238	12.3029	9.2634	2.5764	.9712	275.0062	14.4740	159.2141	118.6869	332.9022	81.0545	83.9493		
IDLE	7.3800	14.4000	4.6500	1.1100	.4320	204.0000	42.0000	132.0000	30.0000	144.0000	42.0000	270.0000	0.0000	.3500
50 KPH	5.0000	13.5000	15.5000	4.6000	1.7200	260.0000	33.5000	265.0000	27.0000	120.0000	27.0000	280.0000	1.3000	2.6500
85 KPH	6.8000	28.0500	46.7500	10.1150	3.7825	161.5000	22.1000	127.5000	136.0000	102.0000	27.2000	136.0000	2.4750	3.0600
FUEL 239														
FTP 3BAG	6.2920	16.0446	20.4490	4.7190	1.7618	160.4460	12.2694	34.6060	40.8980	116.4020	26.4264	6.8086		
FTP C	8.8088	17.9322	20.4490	4.9707	1.8593	195.0520	28.3140	62.9200	37.7520	144.7160	40.8980	0.0000		
FTP H	4.4044	14.1570	18.5614	4.3729	1.6359	135.2780	0.0000	13.5278	40.8980	94.3800	15.7300	15.7300		
CFDS	6.7128	23.4948	27.9700	7.3281	2.7522	61.5340	0.0000	16.2226	0.0000	1515.9740	184.6020	0.0000		
FET	7.7520	29.4576	44.1864	9.3799	3.5039	170.5440	0.0000	0.0000	0.0000	627.9120	61.2408	0.0000		
NYCC	4.4869	13.1713	11.1450	2.5908	.9755	99.8707	0.0000	0.0000	84.7389	680.2785	0.0000	0.0000		
IDLE	6.4800	12.5000	4.8900	1.0900	.4210	378.0000	0.0000	0.0000	384.0000	408.0000	0.0000	0.0000	0.0000	.2200
50 KPH	3.5000	11.5000	17.0000	4.7500	1.7750	85.0000	0.0000	0.0000	0.0000	245.0000	55.0000	0.0000	0.0000	1.1500
85 KPH	8.5000	30.6000	48.4500	9.9450	3.7230	119.0000	9.3500	75.6500	93.5000	110.5000	0.0000	0.0000	2.2450	0.0000
FUEL 240														
FTP 3BAG	5.3482	17.3030	17.9322	4.7819	1.7964	125.8400	12.8986	14.4716	37.7520	97.5260	91.2340	179.3220		
FTP C	7.5504	18.2468	18.2468	5.0336	1.8876	144.7160	22.0220	19.8198	40.8980	113.2560	113.2560	100.6720		
FTP H	4.7190	16.9884	17.6176	4.5932	1.7240	113.2560	5.9774	10.3818	37.7520	84.9420	75.5040	234.0960		
CFDS	6.7128	23.4948	28.5294	7.2722	2.7243	190.1960	16.2226	20.1384	19.0196	151.0380	139.8500	313.2640		
FET	11.6280	35.6592	37.2046	9.3799	3.5272	170.5440	17.8296	44.1864	60.4656	85.2720	0.0000	325.5840		
NYCC	3.7632	13.4608	8.9739	2.5474	.9596	144.7401	23.1584	0.0000	0.0000	118.6869	55.0012	57.8960		
IDLE	3.6000	10.6000	5.7300	1.1900	.4560	132.0000	7.8000	14.4000	16.8000	84.0000	14.4000	144.0000	0.0000	.6700
50 KPH	2.5000	14.5000	15.5000	4.5500	1.7000	90.0000	19.0000	47.0000	65.0000	220.0000	13.5000	21.5000	.3700	1.1500
85 KPH	11.0500	39.1000	71.4000	10.1150	3.7995	187.0000	34.0000	38.2500	28.0500	43.3500	0.0000	204.0000	5.3550	6.0350
FUEL 241														
FTP 3BAG	22.3366	25.4826	18.2468	5.0965	1.9411	597.7400	151.0080	264.2640	72.3580	195.0520	122.6940	245.3880		
FTP C	35.2352	29.2578	18.5614	5.2853	2.0292	723.5800	188.7600	346.0600	69.2120	204.4900	106.4640	406.9800		
FTP H	11.3256	22.0220	18.2468	4.7190	1.7775	503.3600	122.6940	204.4900	72.3580	188.7600	135.2780	122.6940		
CFDS	11.1880	24.0542	31.8858	7.4960	2.8082	212.5720	25.1730	50.4054	36.9204	89.5040	28.5294	117.4740		
FET	11.6280	26.3568	40.3104	9.5350	3.5737	108.5280	17.0544	50.3880	0.0000	147.2880	31.7832	403.1040		
NYCC	15.3425	21.5663	10.1318	2.7356	1.0494	127.3713	0.0000	28.9480	21.7110	141.8453	83.9493	202.6361		
IDLF	17.5000	28.0000	5.5200	1.3100	.5270	384.0000	46.0000	90.0000	55.2000	132.0000	20.4000	162.0000	0.0000	6.7000
50 KPH	53.0000	46.0000	15.0000	4.7000	1.8400	1000.0000	220.0000	165.0000	65.0000	185.0000	55.0000	190.2000	5.0000	13.5000
85 KPH	17.0000	28.0500	45.0500	10.2000	3.8335	280.5000	48.4500	73.9500	102.0000	102.0000	20.4000	119.0000	7.3450	17.8500
FUEL 242														
FTP 3BAG	6.2420	16.3592	19.8198	4.9392	1.8530	195.0520	27.0556	50.3360	56.6280	66.0660	31.4600	0.0000		
FTP C	8.1796	17.9322	19.8198	5.0965	1.9096	254.8260	62.9200	75.5040	59.7740	64.9420	20.1344	0.0000		
FTP H	4.4044	15.1008	20.1344	4.9392	1.8498	147.8620	0.0000	29.2578	53.4820	53.4820	40.8980	0.0000		
CFDS	5.5940	21.2572	31.8858	7.6078	2.8473	100.6920	0.0000	0.0000	5.5940	.5594	0.0000	0.0000		
FET	8.5272	30.2328	44.9616	9.7675	3.6512	100.7760	0.0000	0.0000	294.5760	131.7840	100.7760	0.0000		
NYCC	4.1975	10.8555	10.1318	2.6343	.9886	44.8694	0.0000	0.0000	506.5904	159.2141	144.7401	0.0000		
IDLE	6.3900	11.9000	4.7700	1.1200	.4320	276.0000	102.0000	138.0000	282.0000	114.0000	57.0000	0.0000	0.0000	.5400
50 KPH	3.5000	9.5000	19.0000	4.7500	1.7700	165.0000	12.0000	65.0000	44.5000	70.0000	44.5000	34.5000	0.0000	.5500
85 KPH	6.8000	29.7500	51.0000	10.2850	3.8590	127.5000	0.0000	26.3500	153.0000	153.0000	0.0000	0.0000	3.2400	4.0800

[a] plus acrolein and propanal

[b] plus salicyaldehyde

VW RABBIT DIESEL GASEOUS EMISSIONS - TIME BASIS

```
            VAR. 54a VAR. 55b
            2,4-XYL  2,3-XYL
             MG/HR    MG/HR
            -------- --------
FUEL 238
 FTP 3BAG
 FTP C
 FTP H
 CFDS
 FET
 NYCC
 IDLE        0.0000   0.0000
 50 KPH      0.0000    .0140
 85 KPH      0.0000   0.0000

FUEL 239
 FTP 3BAG
 FTP C
 FTP H
 CFDS
 FET
 NYCC
 IDLE        0.0000   0.0000
 50 KPH      0.0000   0.0000
 85 KPH      0.0000   0.0000

FUEL 240
 FTP 3BAG
 FTP C
 FTP H
 CFDS
 FET
 NYCC
 IDLE        0.0000   0.0000
 50 KPH      0.0000    .0074
 85 KPH      0.0000   0.0000

FUEL 241
 FTP 3BAG
 FTP C
 FTP H
 CFDS
 FET
 NYCC
 IDLE         .1600   6.7000
 50 KPH       .0037    .1600
 85 KPH      0.0000    .0780

FUEL 242
 FTP 3BAG
 FTP C
 FTP H
 CFDS
 FET
 NYCC
 IDLE        0.0000   0.0000
 50 KPH      0.0000   0.0000
 85 KPH      0.0000   0.0000
```

[a] plus 2,5-xylenol
[b] plus 3,5-xylenol

ANALYSIS OF GASEOUS HYDROCARBONS[a] COLLECTED ON CHROMOSORB 102, MERCEDES 240D OPERATED ON EM-238-F FUEL

Weight % off	Temperature in °C by operating procedure or mode							
	Cold FTP	Hot FTP	CFDS	FET	NYCC	Idle	50 kph	85 kph
0(IBP)	246	190	128	152	168	115	230	220
5	260	237	159	210	214	146	251	250
10	269	255	197	242	236	189	258	263
20	282	273	251	273	261	246	272	284
40	306	305	297	314	298	273	297	317
60	332	337	334	345	335	299	319	343
80	370	383	382	386	389	332	348	373
90	401	407	407	405	412	358	369	392
95	415	421	422	416	424	382	384	403
100(EP)	435	433	437	426	437	415	406	421

Carbon number	Normalized abundance of n-paraffins by operating procedure or mode							
	Cold FTP	Hot FTP	CFDS	FET	NYCC	Idle	50 kph	85 kph
9					0.029			
10		0.006	0.006	0.022	0.017	0.008		0.014
11					0.021			
12		0.008	0.006		0.022	0.021		0.014
13	0.046	0.042	0.038	0.027	0.104	0.052	0.024	0.070
14	0.094	0.109	0.148	0.072	0.091	0.105	0.056	0.074
15	0.137	0.194	0.156	0.080	0.122	0.187	0.115	0.114
16	0.131	0.142	0.112	0.077	0.095	0.142	0.117	0.061
17	0.212	0.183	0.168	0.193	0.162	0.199	0.179	0.154
18	0.185	0.157	0.173	0.240	0.136	0.125	0.151	0.166
19	0.133	0.101	0.122	0.166	0.096	0.078	0.148	0.200
20	0.048	0.046	0.060	0.098	0.048	0.044	0.087	0.114
21							0.036	
22							0.015	
23							0.008	
24	0.005				0.016	0.008	0.006	
25							0.046	
26	0.009	0.011	0.010	0.026	0.040	0.031	0.011	0.020
32								
36								
40								
% peak data[b]	70.3	62.4	70.3	80.6	66.3	67.1	67.7	65.8

[a] by ASTM D-2887-73 simulated distillation

[b] sum of paraffins as % of peak area by GC; peak area less than total sample area

ANALYSIS OF GASEOUS HYDROCARBONS[a] COLLECTED ON CHROMOSORB 102, MERCEDES 240D OPERATED ON EM-239-F FUEL

Weight % off	Temperature in °C by operating procedure or mode							
	Cold FTP	Hot FTP	CFDS	FET	NYCC	Idle	50 kph	85 kph
0(IBP)	201	192	206	206	210	317	211	211
5	229	220	243	224	226	320	235	230
10	240	232	252	236	236	324	249	246
20	258	250	272	256	251	332	258	263
40	283	270	306	290	278	349	277	298
60	312	291	344	325	311	373	292	331
80	351	316	387	357	362	396	311	359
90	383	334	414	374	385	403	323	393
95	403	344	431	382	398	407	329	403
100(EP)	431	352	454	391	403	413	336	415

Carbon number	Normalized abundance of n-paraffins by operating procedure or mode							
	Cold FTP	Hot FTP	CFDS	FET	NYCC	Idle	50 kph	85 kph
9								
10	0.001			0.004			0.009	
11				0.005			0.009	
12	0.006	0.005	0.002	0.018	0.032		0.076	0.012
13				0.078	0.125		0.024	0.075
14	0.201	0.251	0.175	0.196	0.188		0.192	0.189
15	0.220	0.225	0.197	0.123	0.151	0.058	0.128	0.125
16	0.171	0.113	0.133	0.070	0.088	0.224	0.138	0.067
17	0.187	0.140	0.162	0.121	0.119	0.336	0.136	0.143
18	0.087	0.089	0.106	0.098	0.069	0.152	0.076	0.114
19	0.069	0.107	0.111	0.142	0.070	0.112	0.065	0.123
20	0.039	0.039	0.063	0.079	0.055	0.065	0.037	0.090
24	0.002	0.004	0.011	0.031		0.019	0.006	
28	0.012	0.016	0.026	0.027	0.085	0.017	0.011	0.046
32		0.011	0.014	0.008	0.018	0.016	0.018	0.016
36							0.040	
40							0.035	
% peak data[b]	48.8	50.2	52.2	51.2	55.6	53.8	77.7	57.7

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[a] by ASTM D-2887-73 simulated distillation

[b] sum of paraffins as % of peak area by GC; peak area less than total sample area

ANALYSIS OF GASEOUS HYDROCARBONS[a] COLLECTED ON CHROMOSORB 102, MERCEDES 240D OPERATED ON EM-240-F FUEL

Weight % off	Temperature in °C by operating procedure or mode							
	Cold FTP	Hot FTP	CFDS	FET	NYCC	Idle	50 kph	85 kph
0(IBP)	251	248	247	195	247	231	250	317
5	263	264	268	210	258	234	255	329
10	278	274	284	217	275	243	260	337
20	310	297	312	236	298	251	272	355
40	366	344	359	356	332	267	302	376
60	407	380	391	380	366	298	335	394
80	445	407	423	399	397	402	373	416
90	464	424	438	408	404	420	391	435
95	479	433	449	415	419	426	400	444
100(EP)	502	448	463	422	426	440	405	468

Carbon number	Normalized abundance of n-paraffins by operating procedure or mode							
	Cold FTP	Hot FTP	CFDS	FET	NYCC	Idle	50 kph	85 kph
9								
10				0.029				
11	0.006			0.038				
12	0.022			0.147	0.246	0.048	0.090	
13			0.026	0.126		0.226	0.218	
14	0.295	0.131	0.090	0.162		0.259	0.181	
15	0.128	0.076	0.103	0.043		0.076	0.086	
16	0.065	0.091	0.085	0.060	0.126	0.063	0.028	0.077
17	0.116	0.129	0.122	0.098		0.113	0.051	0.103
18	0.072	0.059	0.017	0.043			0.043	0.053
19	0.136	0.118	0.126	0.070	0.066		0.057	0.122
20	0.083	0.060	0.051	0.021			0.030	0.046
24	0.027	0.148	0.096	0.091	0.170	0.035	0.075	0.547
26			0.152				0.079	
28	0.035	0.099	0.111	0.073	0.391	0.179	0.061	0.052
32	0.016							
36			0.020					
40								
% peak data[b]	38.2	62.6	48.7	62.6	48.6	55.6	53.0	49.6

[a] by ASTM D-2887-73 simulated distillation

[b] sum of paraffins as % of peak area by GC; peak area less than total sample area

ANALYSIS OF GASEOUS HYDROCARBONS[a] COLLECTED ON CHROMOSORB 102, MERCEDES 240D OPERATED ON EM-241-F FUEL

Weight % off	Temperature in °C by operating procedure or mode							
	Cold FTP	Hot FTP	CFDS	FET	NYCC	Idle	50 kph	85 kph
0(IBP)	149	109	150	144	143	266	100	156
5	224	149	191	211	211	269	134	205
10	250	183	235	232	231	275	159	240
20	274	239	261	262	260	282	226	268
40	312	278	295	299	300	297	269	310
60	365	313	333	339	341	313	304	349
80	403	372	377	389	401	335	346	391
90	426	404	405	416	444	359	386	415
95	445	424	445	436	454	374	392	454
100(EP)	476	468	470	477	463	392	410	470

Carbon number	Normalized abundance of n-paraffins by operating procedure or mode							
	Cold FTP	Hot FTP	CFDS	FET	NYCC	Idle	50 kph	85 kph
9	0.005						0.018	
10	0.016	0.007	0.002	0.016	0.009		0.008	
11	0.001	0.002		0.002				
12	0.002	0.008	0.001	0.003	0.004			
13	0.035				0.042			
14	0.144	0.196	0.152	0.118	0.054		0.054	0.046
15	0.124	0.143	0.136	0.197	0.106	0.086	0.066	0.094
16	0.171	0.147	0.140	0.116	0.059	0.212	0.089	0.070
17	0.182	0.159	0.156	0.119	0.069	0.287	0.115	0.107
18	0.119	0.102	0.107	0.003	0.051	0.285	0.056	0.073
19	0.086	0.062	0.069	0.204	0.298	0.086	0.249	0.277
20	0.032	0.058	0.021	0.007	0.010	0.043	0.005	0.015
24		0.094	0.185	0.189	0.259		0.303	0.279
28	0.078	0.012	0.017	0.027	0.030		0.027	0.029
32	0.005	0.006	0.009		0.008		0.011	0.011
36		0.003	0.004					
40								
% data peak[b]	31.9	45.5	45.6	40.8	59.1	40.5	55.9	54.5

[a] by ASTM D-2887-73 simulated distillation

[b] sum of paraffins as % of peak area by GC; peak area less than total sample area

ANALYSIS OF GASEOUS HYDROCARBONS[a] COLLECTED ON CHROMOSORB 102, MERCEDES 240D OPERATED ON EM-242-F FUEL

Weight % off	Temperature in °C by operating procedure or mode							
	Cold FTP	Hot FTP	CFDS	FET	NYCC	Idle	50 kph	85 kph
0(IBP)	177	107	142	101	117	131	214	82
5	235	167	204	203	143	166	248	212
10	247	211	225	222	169	197	257	230
20	265	246	251	248	215	230	273	258
40	294	281	291	288	261	267	301	303
60	328	311	328	329	307	297	332	339
80	380	346	376	382	385	349	397	378
90	415	388	404	410	418	401	433	401
95	431	406	426	427	436	422	449	421
100(EP)	452	431	455	449	448	443	472	451

Carbon number	Normalized abundance of n-paraffins by operating procedure or mode							
	Cold FTP	Hot FTP	CFDS	FET	NYCC	Idle	50 kph	85 kph
9								
10								
11								
12	0.018	0.126	0.059	0.141	0.238			0.054
13	0.100	0.062	0.109	0.194	0.127		0.053	0.102
14	0.138	0.095	0.092	-----	0.150		0.084	0.063
15	0.124	0.110	0.078	0.145	0.092	0.268	0.182	0.064
16	0.120	0.161	0.099	0.127	0.146	0.239	0.164	0.081
17	0.173	0.195	0.160	0.127	0.125	0.493	0.188	0.167
18	0.158	0.143	0.182	0.143	0.071		0.171	0.236
19	0.115	0.065	0.115	0.071	0.026		0.109	0.151
20	0.046	0.043	0.050	0.053	0.026		0.035	0.082
24	0.008		0.056				0.015	
28								
32								
36								
40								
% peak data[b]	65.9	88.2	67.6	92.3	84.9	100.0	54.9	68.3

[a] by ASTM D-2887-73 simulated distillation

[b] sum of paraffins as % of peak area by GC; peak area less than total sample area

ANALYSIS OF GASEOUS HYDROCARBONS[a] COLLECTED ON CHROMOSORB 102, VW RABBIT DIESEL OPERATED ON EM-238-F FUEL

Weight % off	Temperature in °C by operating procedure or mode							
	Cold FTP	Hot FTP	CFDS	FET	NYCC	Idle	50 kph	85 kph
0(IBP)	241	180	235	176	75	175	217	197
5	263	231	259	230	102	233	250	236
10	274	249	271	250	139	247	260	253
20	291	265	287	270	206	259	274	271
40	313	294	314	308	254	278	298	302
60	340	318	338	335	284	297	317	329
80	387	358	375	372	326	322	345	362
90	414	389	402	399	360	342	367	387
95	431	411	420	418	398	363	387	407
100(EP)	461	460	460	460	437	431	431	450

Carbon number	Normalized abundance of n-paraffins by operating procedure or mode							
	Cold FTP	Hot FTP	CFDS	FET	NYCC	Idle	50 kph	85 kph
6					0.001			
7					0.023			
9				0.001	0.020			
10		0.004		0.002	0.009			0.001
11		0.002		0.008	0.042	0.002		0.002
12		0.016	0.002	0.012	0.046	0.017	0.002	0.006
13	0.004	0.031	0.013	0.040	0.087	0.049	0.017	0.034
14	0.035	0.133	0.071	0.092	0.186	0.109	0.093	0.090
15	0.112	0.171	0.146	0.098	0.156	0.219	0.188	0.108
16	0.152	0.144	0.139	0.085	0.098	0.177	0.176	0.094
17	0.247	0.205	0.199	0.129	0.109	0.172	0.235	0.119
18	0.182	0.136	0.163	0.126	0.078	0.110	0.145	0.103
19	0.148	0.112	0.155	0.147	0.076	0.086	0.094	0.115
20	0.070	0.038	0.080	0.106	0.049	0.049	0.035	0.084
21	0.022	0.008	0.024	0.073	0.010	0.010	0.007	0.059
22	0.006		0.003	0.048	0.001	0.001	0.003	0.042
23	0.006		0.002	0.033	0.001	0.001	0.002	0.065
24	0.015		0.002				0.001	0.023
28							0.001	0.054
32								
36								
40								
% peak data[b]	55.9	62.0	59.1	44.6	51.4	56.8	63.2	55.1

[a] by ASTM D-2887-73 simulated distillation

[b] sum of paraffins as % of peak area by GC; peak area less than total sample area

ANALYSIS OF GASEOUS HYDROCARBONS[a] COLLECTED ON CHROMOSORB 102, VW RABBIT DIESEL OPERATED ON EM-239-F FUEL

Weight % off	Temperature in °C by operating procedure or mode							
	Cold FTP	Hot FTP	CFDS	FET	NYCC	Idle	50 kph	85 kph
0(IBP)	NO DATA	226	223	NO DATA	229	201	NO DATA	229
5		239	242		240	221		253
10		250	252		251	232		263
20		259	265		263	244		289
40		271	289		287	259		329
60		289	311		307	270		354
80		304	333		334	290		375
90		310	345		354	301		389
95		314	349		364	307		401
100(EP)		318	353		376	313		417

Carbon number	Normalized abundance of n-paraffins by operating procedure or mode							
	Cold FTP	Hot FTP	CFDS	FET	NYCC	Idle	50 kph	85 kph
9		NO DATA	NO DATA	NO DATA	NO DATA		NO DATA	NO DATA
10	0.044							
11								
12						0.037		
13								
14						0.235		
15	0.236					0.261		
16	0.347					0.177		
17	0.293					0.189		
18	0.081					0.100		
19								
20								
24								
28								
32								
36								
40								
% peak data[b]	29.7					42.9		

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[a] by ASTM-2887-73 simulated distillation

[b] sum of paraffins as % of peak area by GC; peak area less than total sample area

ANALYSIS OF GASEOUS HYDROCARBONS[a] COLLECTED ON CHROMOSORB 102, VW RABBIT DIESEL OPERATED ON EM-240-F FUEL

Weight % off	Temperature in °C by operating procedure or mode							
	Cold FTP	Hot FTP	CFDS	FET	NYCC	Idle	50 kph	85 kph
0(IBP)	223	236	332	NO DATA	233	264	NO DATA	206
5	233	249	374		239	273		221
10	241	263	394		249	284		235
20	258	290	402		268	318		259
40	297	350	428		329	376		329
60	358	383	466		401	421		360
80	413	421	493		467	460		401
90	446	454	503		492	487		430
95	470	483	511		505	502		457
100(EP)	512	516	520		518	518		510

Carbon number	Normalized abundance of n-paraffins by operating procedure or mode							
	Cold FTP	Hot FTP	CFDS	FET	NYCC	Idle	50 kph	85 kph
9			NO DATA	NO DATA		NO DATA		
10	0.025						0.009	
11								
12							0.149	0.027
13	0.239				0.538		0.169	0.229
14	0.478	0.046			0.215		0.117	0.270
15	0.048	0.055			0.247		0.143	0.099
16	0.142	0.041					0.037	
17	0.046	0.041					0.029	0.020
18							0.020	
19							0.057	
20		0.410					0.129	0.355
24		0.406					0.123	
28		0.046					0.020	
32								
36								
40								
% peak data[b]	39.3	21.7			28.8		35.0	29.3

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[a] by ASTM-2887-73 simulated distillation

[b] sum of paraffins as % of peak area by GC; peak area less than total sample area

ANALYSIS OF GASEOUS HYDROCARBONS[a] COLLECTED ON CHROMOSORB 102, VW RABBIT DIESEL OPERATED ON EM-241-F FUEL

Weight % off	Temperature in °C by operating procedure or mode							
	Cold FTP	Hot FTP	CFDS	FET	NYCC	Idle	50 kph	85 kph
0(IBP)	84	NO DATA	NO DATA	150	NO DATA	218	196	195
5	144			207		231	224	236
10	234			221		237	233	251
20	251			237		249	248	263
40	268			262		263	265	281
60	282			283		280	283	294
80	301			304		300	304	309
90	313			317		311	320	318
95	324			330		322	335	327
100(EP)	338			342		346	351	335

Carbon number	Normalized abundance of n-paraffins by operating procedure or mode							
	Cold FTP	Hot FTP	CFDS	FET	NYCC	Idle	50 kph	85 kph
6	0.005							
7	0.006		0.003					
9	0.005							
10	0.001	0.004		0.004				
11		0.001					0.002	
12	0.004	0.025	0.010	0.053		0.028	0.024	0.008
13	0.045	0.150	0.089	0.117	0.102	0.138	0.123	0.040
14	0.218	0.156	0.191	0.163	0.160	0.149	0.140	0.107
15	0.158	0.141	0.160	0.115	0.216	0.159	0.141	0.124
16	0.173	0.191	0.197	0.159	0.235	0.168	0.159	0.211
17	0.134	0.181	0.181	0.176	0.174	0.133	0.130	0.204
18	0.078	0.071	0.095	0.103	0.054	0.121	0.084	0.115
19	0.085	0.057	0.059	0.082	0.046	0.073	0.096	0.123
20	0.049	0.020	0.012	0.028	0.014	0.030	0.035	0.039
21	0.025	0.003					0.033	0.026
22	0.010							0.003
23	0.003							
24							0.018	
28							0.015	
32								
36								
40								
% peak data[b]	55.6	64.7	56.2	62.0	58.7	52.9	54.4	57.9

[a] by ASTM-2887-73 simulated distillation

[b] sum of paraffins as % of peak area by GC; peak area less than total sample area

ANALYSIS OF GASEOUS HYDROCARBONS[a] COLLECTED ON CHROMOSORB 102, VW RABBIT DIESEL OPERATED ON EM-242-F FUEL

Weight % off	Temperature in °C by Operating Procedure or Mode							
	Cold FTP	Hot FTP	CFDS	FET	NYCC	Idle	50 kph	85 kph
0(IBP)	NO DATA	220	216	SAMPLE	212	214	203	NO DATA
5		239	238	LOST	228	232	230	
10		251	249		240	240	247	
20		264	267		255	254	276	
40		291	303		278	269	322	
60		312	332		304	293	347	
80		338	359		329	315	368	
90		355	381		350	333	382	
95		367	395		362	343	392	
100(EP)		382	416		377	358	410	

Carbon number	Normalized abundance of n-paraffins by operating procedure or mode							
	Cold FTP	Hot FTP	CFDS	FET	NYCC	Idle	50 kph	85 kph
9	NO DATA	NO DATA		SAMPLE	NO DATA		NO DATA	NO DATA
10				LOST				
11			0.002					
12			0.044					
13								
14			0.144			0.195		
15			0.275			0.268		
16			0.172			0.289		
17			0.210			0.247		
18			0.108					
19								
20			0.044					
24								
28								
32								
36								
40								
% peak data[b]			49.9			48.1		

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[a] by ASTM D-2887-73 simulated distillation

[b] sum of paraffins as % of peak area by GC; peak area less than total sample area

COMPARISON OF ODOR PANEL RATINGS - MERCEDES 240D
Fuel: EM-238-F

Operating Condition	Date	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
		Steady State Results				
Inter. Speed 2% Load	9/21/77	1.8	0.9	0.7	0.4	0.2
	9/23/77	2.2	1.0	0.9	0.5	0.3
	Average	2.0	1.0	0.8	0.4	0.2
Inter. Speed 50% Load	9/21/77	2.1	1.0	0.8	0.4	0.2
	9/23/77	1.7	0.9	0.7	0.3	0.2
	Average	1.9	1.0	0.8	0.4	0.2
Inter. Speed 100% Load	9/21/77	2.3	1.0	0.8	0.4	0.2
	9/23/77	2.5	1.0	0.9	0.5	0.3
	Average	2.4	1.0	0.8	0.4	0.2
High Speed 2% Load	9/21/77	2.1	1.0	0.7	0.5	0.2
	9/23/77	2.5	1.0	0.9	0.4	0.2
	Average	2.3	1.0	0.8	0.4	0.2
High Speed 50% Load	9/21/77	2.2	1.0	0.7	0.5	0.2
	9/23/77	1.9	1.0	0.7	0.4	0.3
	Average	2.0	1.0	0.7	0.4	0.2
High Speed 100% Load	9/21/77	2.6	1.0	0.9	0.5	0.3
	9/23/77	2.9	1.0	0.9	0.6	0.5
	Average	2.8	1.0	0.9	0.6	0.4
Idle	9/21/77	2.1	1.0	0.8	0.4	0.2
	9/23/77	2.0	1.0	0.9	0.4	0.2
	Average	2.0	1.0	0.8	0.4	0.2
		Transient Results				
Idle-Acceleration	9/21/77	2.7	1.1	1.0	0.6	0.4
	9/23/77	2.8	1.1	1.0	0.5	0.5
	Average	2.8	1.1	1.0	0.6	0.4
Acceleration	9/21/77	2.6	1.0	0.9	0.5	0.4
	9/23/77	2.4	1.0	0.9	0.6	0.2
	Average	2.5	1.0	0.9	0.6	0.3
Deceleration	9/21/77	4.1	1.5	1.1	0.8	0.8
	9/23/77	4.3	1.2	1.1	0.9	1.1
	Average	4.2	1.4	1.1	0.8	1.0
Cold Start	9/21/77	3.9	1.5	1.0	0.8	0.7
	9/23/77	4.1	1.4	1.0	0.9	0.9
	Average	4.0	1.4	1.0	0.8	0.8

COMPARISON OF ODOR PANEL RATINGS - MERCEDES 240D
Fuel: EM-239-F

Operating Condition	Date	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
Steady State Results						
Inter. Speed 0 Load	9/16/77	2.3	1.0	0.8	0.4	0.2
	9/19/77	2.1	0.9	0.8	0.4	0.3
	Average	2.2	1.0	0.8	0.4	0.2
Inter. Speed Mid Load	9/16/77	2.0	1.0	0.7	0.5	0.1
	9/19/77	2.0	0.9	0.7	0.3	0.2
	Average	2.0	1.0	0.7	0.4	0.2
Inter. Speed High Load	9/16/77	2.9	1.1	0.9	0.5	0.4
	9/19/77	2.4	1.0	0.8	0.5	0.2
	Average	2.6	1.0	0.8	0.5	0.3
High Speed 0 Load	9/16/77	2.0	0.9	0.8	0.3	0.1
	9/19/77	2.1	1.0	0.6	0.4	0.3
	Average	2.0	1.0	0.7	0.4	0.2
High Speed Mid Load	9/16/77	2.3	1.0	0.8	0.6	0.2
	9/19/77	2.1	1.0	0.8	0.3	0.2
	Average	2.2	1.0	0.8	0.4	0.2
High Speed High Load	9/16/77	3.1	1.1	1.0	0.6	0.4
	9/19/77	2.7	1.0	0.9	0.6	0.3
	Average	2.9	1.0	1.0	0.6	0.4
Idle	9/16/77	2.3	1.0	0.8	0.3	0.2
	9/19/77	2.3	1.1	0.9	0.5	0.2
	Average	2.3	1.0	0.8	0.4	0.2
Transient Results						
Idle-Acceleration	9/16/77	3.1	1.1	1.0	0.6	0.5
	9/19/77	2.8	1.1	1.0	0.6	0.4
	Average	3.0	1.1	1.0	0.6	0.4
Acceleration	9/16/77	3.1	1.2	1.0	0.7	0.4
	9/19/77	2.7	1.0	0.9	0.6	0.3
	Average	2.9	1.1	1.0	0.6	0.4
Deceleration	9/16/77	5.0	1.9	1.2	0.8	1.0
	9/19/77	4.7	1.8	1.1	0.8	0.9
	Average	4.8	1.8	1.2	0.8	1.0
Cold Start	9/16/77	3.1	1.1	1.0	0.9	0.2
	9/19/77	2.5	1.0	1.0	0.6	0.2
	Average	2.8	1.0	1.0	0.8	0.2

COMPARISON OF ODOR PANEL RATINGS - MERCEDES 240D
Fuel: EM-240-F

Operating Condition	Date	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
Steady State Results						
Inter. Speed 2% Load	9/26/77	2.1	1.0	0.8	0.4	0.2
	9/28/77	2.1	1.0	0.8	0.3	0.2
	Average	2.1	1.0	0.8	0.4	0.2
Inter. Speed 50% Load	9/26/77	1.9	1.0	0.8	0.4	0.1
	9/28/77	1.9	1.0	0.7	0.3	0.2
	Average	1.9	1.0	0.8	0.4	0.2
Inter. Speed 100% Load	9/26/77	1.9	1.0	0.6	0.4	0.2
	9/28/77	2.0	1.1	0.8	0.4	0.2
	Average	2.0	1.0	0.7	0.4	0.2
High Speed 2%	9/26/77	2.2	1.0	0.7	0.4	0.2
	9/28/77	2.1	1.1	0.7	0.5	0.2
	Average	2.2	1.0	0.7	0.4	0.2
High Speed 50% Load	9/26/77	1.8	1.0	0.7	0.3	0.2
	9/28/77	1.8	1.0	0.7	0.3	0.2
	Average	1.8	1.0	0.7	0.3	0.2
High Speed 100% Load	9/26/77	2.6	1.0	0.8	0.5	0.5
	9/28/77	2.5	1.1	0.8	0.6	0.3
	Average	2.6	1.0	0.8	0.6	0.4
Idle	9/26/77	2.1	1.0	0.8	0.4	0.2
	9/28/77	2.2	1.0	0.9	0.4	0.2
	Average	2.2	1.0	0.8	0.4	0.2
Transient Results						
Idle-Acceleration	9/26/77	2.3	1.0	0.9	0.4	0.2
	9/28/77	2.9	1.1	1.0	0.6	0.4
	Average	2.6	1.0	1.0	0.5	0.3
Acceleration	9/26/77	2.4	1.0	1.0	0.6	0.2
	9/28/77	2.4	1.0	1.0	0.4	0.2
	Average	2.4	1.0	1.0	0.5	0.2
Deceleration	9/26/77	4.3	1.4	1.0	0.8	0.9
	9/28/77	4.4	1.6	1.1	0.7	0.9
	Average	4.4	1.5	1.0	0.8	0.9
Cold Start	9/26/77	3.0	1.2	1.0	0.6	0.4
	9/28/77	2.7	1.0	0.9	0.5	0.4
	Average	2.8	1.1	1.0	0.6	0.4

COMPARISON OF ODOR PANEL RATINGS - MERCEDES 240D
Fuel: EM-241-F

Steady State Results

Operating Condition	Date	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
Inter. Speed 2% Load	9/30/77	1.9	1.1	0.7	0.4	0.1
	10/3/77	2.4	1.0	0.8	0.4	0.2
	Average	2.2	1.0	0.8	0.4	0.2
Inter. Speed 50% Load	9/30/77	1.7	1.0	0.6	0.3	0.1
	10/3/77	2.0	1.0	0.8	0.2	0.1
	Average	1.8	1.0	0.7	0.2	0.1
Inter. Speed 100% Load	9/30/77	2.3	1.0	0.8	0.6	0.3
	10/3/77	2.0	1.0	0.8	0.3	0.1
	Average	2.2	1.0	0.8	0.4	0.2
High Speed 2% Load	9/30/77	1.9	1.0	0.8	0.3	0.2
	10/3/77	2.4	1.1	0.9	0.4	0.1
	Average	2.2	1.0	0.8	0.4	0.2
High Speed 50% Load	9/30/77	1.9	1.1	0.7	0.3	0.2
	10/3/77	2.2	1.0	0.8	0.3	0.2
	Average	2.0	1.0	0.8	0.3	0.2
High Speed 100% Load	9/30/77	2.5	1.1	0.8	0.6	0.3
	10/3/77	2.8	1.0	0.9	0.6	0.3
	Average	2.6	1.0	0.8	0.6	0.3
Idle	9/30/77	1.9	1.0	0.8	0.3	0.2
	10/3/77	2.5	1.0	0.9	0.5	0.2
	Average	2.2	1.0	0.8	0.4	0.2

Transient Results

Operating Condition	Date	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
Idle-Acceleration	9/30/77	2.7	1.1	0.9	0.7	0.3
	10/3/77	3.0	1.1	1.0	0.6	0.6
	Average	2.8	1.1	1.0	0.6	0.4
Acceleration	9/30/77	2.8	1.0	1.0	0.6	0.3
	10/3/77	2.5	1.0	0.9	0.6	0.2
	Average	2.6	1.0	1.0	0.6	0.2
Deceleration	9/30/77	4.3	1.5	1.1	0.7	0.9
	10/3/77	4.6	1.7	1.0	0.8	0.9
	Average	4.4	1.6	1.0	0.8	0.9
Cold Start	9/30/77	3.9	1.7	1.0	0.4	0.9
	10/3/77	4.0	1.3	1.0	0.9	0.9
	Average	4.0	1.5	1.0	0.6	0.9

COMPARISON OF ODOR PANEL RATING - MERCEDES 240D
Fuel: EM-242-F

Operating Condition	Date	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
		Steady State Results				
Inter. Speed 2% Load	10/5/77	2.1	1.1	0.8	0.4	0.2
	10/7/77	1.8	1.0	0.7	0.3	0.1
	Average	2.0	1.0	0.8	0.4	0.2
Inter. Speed 50% Load	10/5/77	1.9	1.0	0.8	0.4	0.1
	10/7/77	1.9	1.0	0.8	0.3	0.1
	Average	1.9	1.0	0.8	0.4	0.1
Inter. Speed 100% Load	10/5/77	2.1	1.0	0.8	0.4	0.2
	10/7/77	2.7	1.1	1.0	0.6	0.2
	Average	2.4	1.0	0.9	0.5	0.2
High Speed 2% Load	10/5/77	1.8	1.1	0.8	0.3	0.2
	10/7/77	2.1	1.0	0.9	0.3	0.1
	Average	2.0	1.0	0.8	0.3	0.2
High Speed 50% Load	10/5/77	2.3	1.1	0.9	0.5	0.2
	10/7/77	2.3	1.1	0.9	0.5	0.2
	Average	2.3	1.1	0.9	0.5	0.2
High Speed 100% Load	10/5/77	2.9	1.1	1.0	0.6	0.5
	10/7/77	2.5	1.0	0.9	0.5	0.1
	Average	2.7	1.0	1.0	0.6	0.3
Idle	10/5/77	2.2	1.0	0.8	0.5	0.2
	10/7/77	2.2	1.0	0.8	0.4	0.2
	Average	2.2	1.0	0.8	0.4	0.2
		Transient Results				
Idle-Acceleration	10/5/77	2.4	1.0	0.9	0.6	0.3
	10/7/77	2.6	1.0	0.9	0.7	0.2
	Average	2.5	1.0	0.9	0.6	0.2
Acceleration	10/5/77	2.6	1.0	1.0	0.6	0.3
	10/7/77	2.4	1.1	0.9	0.4	0.2
	Average	2.5	1.0	1.0	0.5	0.2
Deceleration	10/5/77	4.3	1.6	1.0	0.8	0.8
	10/7/77	3.7	1.2	1.0	1.1	0.8
	Average	4.0	1.4	1.0	1.0	0.8
Cold Start	10/5/77	4.1	1.1	1.0	0.9	0.9
	10/7/77	4.1	1.2	1.0	1.1	0.8
	Average	4.1	1.2	1.0	1.0	0.8

COMPARISON OF ODOR PANEL RATINGS - VW RABBIT
Fuel: EM-238-F

Operating Condition	Date	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
		Steady State Results				
Inter. Speed 0 Load	8/26/77	2.6	1.2	0.7	0.5	0.3
	8/29/77	2.8	0.9	0.8	0.6	0.3
	Average	2.7	1.0	0.8	0.6	0.3
Inter. Speed Mid Load	8/26/77	2.7	1.1	0.8	0.4	0.4
	8/29/77	2.3	1.0	0.8	0.3	0.2
	Average	2.5	1.0	0.8	0.4	0.3
Inter. Speed High Load	8/26/77	2.7	1.1	0.8	0.4	0.4
	8/29/77	3.4	1.2	0.9	0.4	0.5
	Average	3.0	1.2	0.8	0.4	0.4
High Speed 0 Load	8/26/77	2.3	1.0	0.7	0.4	0.3
	8/29/77	2.5	1.0	0.7	0.4	0.2
	Average	2.4	1.0	0.7	0.4	0.2
High Speed Mid Load	8/26/77	2.5	1.0	0.8	0.3	0.3
	8/29/77	2.9	1.0	0.8	0.4	0.4
	Average	2.7	1.0	0.8	0.4	0.4
High Speed High Load	8/26/77	2.9	1.1	0.9	0.6	0.3
	8/29/77	3.1	1.1	0.9	0.5	0.4
	Average	3.0	1.1	0.9	0.6	0.4
Idle	8/26/77	2.9	1.1	0.8	0.6	0.4
	8/29/77	2.9	1.1	0.8	0.5	0.3
	Average	2.9	1.1	0.8	0.6	0.4
		Transient Results				
Idle-Acceleration	8/26/77	3.2	1.2	0.9	0.4	0.5
	8/29/77	3.9	1.3	1.0	0.6	0.8
	Average	3.6	1.2	1.0	0.5	0.6
Acceleration	8/26/77	3.4	1.2	0.9	0.6	0.6
	8/29/77	4.0	1.3	1.0	0.8	0.8
	Average	3.7	1.2	1.0	0.7	0.7
Deceleration	8/26/77	3.0	1.1	0.9	0.6	0.5
	8/29/77	3.1	1.1	0.9	0.6	0.4
	Average	3.0	1.1	0.9	0.6	0.4
Cold Start	8/26/77	3.8	1.1	1.0	0.8	0.6
	8/29/77	4.4	1.4	1.0	0.6	0.9
	Average	4.1	1.2	1.0	0.7	0.8

COMPARISON OF ODOR PANEL RATINGS - VW RABBIT
Fuel: EM-239-F

Operating Condition	Date	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
		Steady State Results				
Inter. Speed 0 Load	8/22/77	2.9	1.1	0.7	0.6	0.4
	8/24/77	2.4	1.1	0.7	0.3	0.2
	Average	2.6	1.1	0.7	0.4	0.3
Inter. Speed Mid Load	8/22/77	2.3	1.0	0.7	0.4	0.3
	8/24/77	2.4	1.1	0.7	0.3	0.2
	Average	2.4	1.0	0.7	0.4	0.3
Inter. Speed High Load	8/22/77	3.3	1.1	0.9	0.6	0.5
	8/24/77	3.5	1.3	1.0	0.4	0.8
	Average	3.4	1.2	1.0	0.5	0.6
High Speed 0 Load	8/22/77	2.2	1.0	0.8	0.4	0.1
	8/24/77	2.2	1.1	0.7	0.2	0.2
	Average	2.2	1.0	0.8	0.3	0.2
High Speed Mid Load	8/22/77	2.9	1.0	1.0	0.5	0.3
	8/24/77	2.5	1.1	0.8	0.4	0.3
	Average	2.6	1.0	0.9	0.4	0.3
High Speed High Load	8/22/77	2.8	1.0	0.9	0.4	0.5
	8/24/77	3.4	1.2	1.0	0.4	0.6
	Average	3.1	1.1	1.0	0.4	0.6
Idle	8/22/77	3.3	1.1	1.0	0.7	0.6
	8/24/77	3.4	1.2	0.9	0.6	0.5
	Average	3.4	1.2	1.0	0.6	0.6
		Transient Results				
Idle-Acceleration	8/22/77	3.1	1.1	0.9	0.6	0.5
	8/24/77	3.4	1.2	1.0	0.5	0.7
	Average	3.2	1.2	1.0	0.6	0.6
Acceleration	8/22/77	3.5	1.2	1.0	0.6	0.7
	8/24/77	3.7	1.2	0.9	0.6	0.8
	Average	3.6	1.2	1.0	0.6	0.8
Deceleration	8/22/77	2.7	1.0	0.9	0.4	0.4
	8/24/77	2.9	1.1	0.9	0.5	0.5
	Average	2.8	1.1	0.9	0.4	0.4
Cold Start	8/22/77	No data				
	8/24/77	5.0	2.1	1.0	0.8	0.8

COMPARISON OF ODOR RATINGS - VW RABBIT

Fuel: EM-240-F

Operating Condition	Date	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
		Steady State Results				
Inter. Speed 0 Load	8/31/77	2.7	1.0	0.9	0.4	0.3
	9/2/77	2.6	1.0	0.8	0.4	0.3
	Average	2.6	1.0	0.8	0.4	0.3
Inter. Speed Mid Load	8/31/77	3.0	1.3	0.9	0.4	0.5
	9/2/77	2.3	1.0	0.9	0.3	0.3
	Average	2.6	1.2	0.9	0.4	0.4
Inter. Speed High Load	8/31/77	2.7	1.1	1.0	0.3	0.3
	9/2/77	3.5	1.5	1.0	0.3	0.8
	Average	3.1	1.3	1.0	0.3	0.6
High Speed 0 Load	8/31/77	3.5	1.2	1.0	0.5	0.6
	9/2/77	2.7	1.0	0.9	0.6	0.3
	Average	3.1	1.1	1.0	0.6	0.4
High Speed Mid Load	8/31/77	3.0	1.0	0.9	0.4	0.6
	9/2/77	3.0	1.1	0.9	0.6	0.5
	Average	3.0	1.0	0.9	0.5	0.6
High Speed High Load	8/31/77	2.8	1.1	0.9	0.5	0.5
	9/2/77	3.1	1.1	1.0	0.5	0.4
	Average	3.0	1.1	1.0	0.5	0.4
Idle	8/31/77	3.1	1.1	0.9	0.6	0.5
	9/2/77	3.0	1.1	0.9	0.6	0.3
	Average	3.0	1.1	0.9	0.6	0.4
		Transient Results				
Idle-Acceleration	8/31/77	3.4	1.1	1.0	0.7	0.6
	9/2/77	3.2	1.2	0.9	0.6	0.4
	Average	3.3	1.2	1.0	0.6	0.5
Acceleration	8/31/77	3.4	1.1	0.9	0.6	0.7
	9/2/77	3.2	1.1	1.0	0.6	0.5
	Average	3.3	1.1	1.0	0.6	0.6
Deceleration	8/31/77	3.4	1.2	1.0	0.6	0.5
	9/2/77	3.2	1.2	0.9	0.6	0.5
	Average	3.3	1.2	1.0	0.6	0.5
Cold Start	8/31/77	3.9	1.4	1.0	0.8	0.6
	9/2/77	4.1	1.4	1.0	0.9	0.8
	Average	4.0	1.4	1.0	0.8	0.7

SUMMARY OF ODOR PANEL RATINGS - VW RABBIT

Fuel: EM-241-F

Operating Condition	Date	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
		Steady State Results				
Inter. Speed 0 Load	9/7/77	2.7	1.0	0.9	0.4	0.3
	9/9/77	2.9	1.0	0.9	0.4	0.4
	Average	2.8	1.0	0.9	0.4	0.4
Inter. Speed Mid Load	9/7/77	2.4	1.0	0.9	0.3	0.3
	9/9/77	2.6	1.0	0.8	0.4	0.2
	Average	2.5	1.0	0.8	0.4	0.2
Inter. Speed High Load	9/7/77	3.6	1.3	1.0	0.6	0.6
	9/9/77	3.4	1.1	0.9	0.7	0.5
	Average	3.5	1.2	1.0	0.6	0.6
High Speed 0 Load	9/7/77	2.7	1.0	0.9	0.3	0.3
	9/9/77	2.9	1.0	0.9	0.5	0.3
	Average	2.8	1.0	0.9	0.4	0.3
High Speed Mid Load	9/7/77	3.2	1.2	1.0	0.4	0.5
	9/9/77	3.3	1.2	0.9	0.5	0.5
	Average	3.2	1.2	1.0	0.4	0.5
High Speed High Load	9/7/77	3.1	1.0	0.9	0.4	0.6
	9/9/77	3.5	1.3	0.9	0.4	0.6
	Average	3.3	1.2	0.9	0.4	0.6
Idle	9/7/77	3.7	1.2	1.0	0.7	0.7
	9/9/77	3.2	1.0	0.9	0.6	0.6
	Average	3.4	1.1	1.0	0.6	0.6
		Transient Results				
Idle-Acceleration	9/7/77	4.2	1.6	1.0	0.7	0.9
	9/9/77	3.6	1.1	1.0	0.7	0.7
	Average	3.9	1.4	1.0	0.7	0.8
Acceleration	9/7/77	4.8	1.8	1.3	0.7	0.9
	9/9/77	4.0	1.5	1.0	0.6	0.7
	Average	4.4	1.6	1.2	0.6	0.8
Deceleration	9/7/77	3.9	1.2	1.0	0.7	0.9
	9/9/77	3.5	1.1	1.0	0.5	0.8
	Average	3.7	1.2	1.0	0.6	0.8
Cold Start	9/7/77	4.8	1.8	1.3	0.4	1.0
	9/9/77	5.9	2.0	1.6	0.9	1.3
	Average	5.4	1.9	1.4	0.6	1.2

COMPARISON OF ODOR PANEL RATINGS - VW RABBIT

Fuel: EM-242-F

Operating Condition	Date	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
		Steady State Results				
Inter. Speed 0 Load	9/12/77	2.6	1.0	0.8	0.4	0.3
	9/14/77	2.5	1.0	0.9	0.7	0.3
	Average	2.6	1.0	0.8	0.6	0.3
Inter. Speed Mid Load	9/12/77	2.6	1.0	0.9	0.3	0.2
	9/14/77	2.6	1.0	0.8	0.6	0.3
	Average	2.6	1.0	0.8	0.4	0.2
Inter. Speed High Load	9/12/77	2.9	1.1	0.9	0.4	0.2
	9/14/77	2.8	1.1	1.0	0.4	0.3
	Average	2.8	1.1	1.0	0.4	0.2
High Speed 0 Load	9/12/77	2.3	1.0	0.9	0.4	0.1
	9/14/77	2.2	1.0	0.8	0.4	0.2
	Average	2.2	1.0	0.8	0.4	0.2
High Speed Mid Load	9/12/77	2.9	1.1	1.0	0.4	0.3
	9/14/77	2.8	1.0	0.9	0.5	0.5
	Average	2.8	1.0	1.0	0.4	0.4
High Speed High Load	9/12/77	3.0	1.1	0.9	0.5	0.4
	9/14/77	2.8	1.0	1.0	0.5	0.4
	Average	2.9	1.0	1.0	0.5	0.4
Idle	9/12/77	2.9	1.0	0.9	0.3	0.5
	9/14/77	2.7	1.0	0.9	0.5	0.4
	Average	2.8	1.0	0.9	0.4	0.4
		Transient Results				
Idle-Acceleration	9/12/77	3.8	1.5	1.0	0.7	0.8
	9/14/77	3.0	1.0	1.0	0.6	0.6
	Average	3.4	1.2	1.0	0.6	0.7
Acceleration	9/12/77	3.8	1.3	1.0	0.5	0.8
	9/14/77	3.7	1.2	1.0	0.8	0.7
	Average	3.8	1.2	1.0	0.6	0.8
Deceleration	9/12/77	3.1	1.0	0.9	0.6	0.5
	9/14/77	2.9	1.0	1.0	0.5	0.7
	Average	3.0	1.0	1.0	0.6	0.6
Cold Start	9/12/77	5.2	1.9	1.3	0.7	0.8
	9/14/77	4.5	1.4	1.1	0.9	1.0
	Average	4.8	1.6	1.2	0.8	0.9

COMPARISON OF GASEOUS EMISSIONS

VEHICLE: Mercedes 240D FUEL: EM-238-F

					C.L.		DOAS	Results	
Operating Condition	Date	HC, ppm	CO, ppm	CO_2, %	NO, ppm	NO_x, ppm	LCA, µg/l	LCO, µg/l	TIA
Inter. Speed 2% Load	9/21/77	43	206	2.4	107	102	3.4	1.8	1.3
	9/23/77	68	205	2.5	64	60	11.4	5.1	1.7
	Average	56	206	2.4	86	81	7.4	3.4	1.5
Inter. Speed 50% Load	9/21/77	36	154	6.9	271	263	5.3	3.4	1.5
	9/23/77	41	155	7.1	290	293	5.6	3.0	1.5
	Average	38	154	7.0	280	278	5.4	3.2	1.5
Inter. Speed 100% Load	9/21/77	28	244	11.7	294	285	3.0	2.4	1.4
	9/23/77	38	274	12.0	328	328	9.1	4.3	1.6
	Average	33	259	11.8	311	306	6.0	3.4	1.5
High Speed 2% Load	9/21/77	55	392	3.3	77	74	4.4	1.8	1.3
	9/23/77	59	368	3.3	85	82	5.5	2.6	1.4
	Average	57	380	3.3	81	78	5.0	2.2	1.4
High Speed 50% Load	9/21/77	28	196	7.8	311	306	4.0	2.2	1.3
	9/23/77	29	191	7.7	311	300	4.2	2.6	1.4
	Average	28	194	7.8	311	303	4.1	2.4	1.4
High Speed 100% Load	9/21/77	24	362	12.5	375	367	4.0	3.1	1.5
	9/23/77	31	322	11.9	412	405	5.2	3.9	1.6
	Average	28	342	12.2	394	386	4.6	3.5	1.6
Idle	9/21/77	69	158	2.7	90	87	7.9	2.3	1.3
	9/23/77	91	170	2.8	99	91	7.0	2.3	1.4
	Average	80	164	2.8	94	89	7.4	2.3	1.4

SUMMARY OF GASEOUS EMISSIONS

VEHICLE: Mercedes 240D FUEL: EM-239-F

					C.L.		DOAS Results		
Operating Condition	Date	HC, ppm	CO, ppm	CO_2, %	NO, ppm	NO_x, ppm	LCA, µg/l	LCO, µg/l	TIA
Inter. Speed 2% Load	9/16/77	73	200	2.5	60	57	8.9	3.7	1.6
	9/19/77	57	198	2.5	69	65	4.1	2.2	1.3
	Average	65	199	2.5	65	61	6.5	3.0	1.4
Inter. Speed 50% Load	9/16/77	43	188	7.0	291	279	8.6	3.9	1.6
	9/19/77	37	153	6.8	310	317	2.6	1.7	1.2
	Average	40	170	6.9	300	298	5.6	2.8	1.4
Inter. Speed 100% Load	9/16/77	43	256	12.1	326	321	11.0	6.1	1.8
	9/19/77	36	277	11.9	345	345	3.1	2.9	1.5
	Average	40	266	12.0	336	333	7.0	4.5	1.6
High Speed 2% Load	9/16/77	64	435	3.3	88	80	8.1	5.0	1.7
	9/19/77	55	427	3.3	84	78	4.0	2.1	1.3
	Average	60	431	3.3	86	79	6.0	3.6	1.5
High Speed 50% Load	9/16/77	31	198	7.9	322	319	8.2	5.5	1.7
	9/19/77	32	200	7.7	342	342	5.0	3.2	1.5
	Average	32	199	7.8	332	330	6.6	4.4	1.6
High Speed 100% Load	9/16/77	34	411	12.2	448	448	8.2	5.5	1.7
	9/19/77	41	329	12.6	443	450	5.0	5.5	1.8
	Average	38	370	12.4	446	449	6.6	5.5	1.8
Idle	9/16/77	94	182	2.7	91	84	6.5	2.9	1.5
	9/19/77	112	184	2.8	100	97	9.8	3.6	1.6
	Average	103	183	2.8	96	90	8.2	3.2	1.6

SUMMARY OF GASEOUS EMISSIONS MEASUREMENTS

VEHICLE: Mercedes 240D

FUEL: EM-240-F

					C.L.		DOAS Results		
Operating Condition	Date	HC, ppm	CO, ppm	CO_2, %	NO, ppm	NO_x, ppm	LCA, µg/l	LCO, µg/l	TIA
Inter. Speed 2% Load	9/26/77	50	219	2.4	58	56	15.8	3.6	1.6
	9/28/77	46	192	2.5	56	60	17.7	2.7	1.4
	Average	48	206	2.4	57	58	16.8	3.2	1.5
Inter. Speed 50% Load	9/26/77	33	157	7.1	261	258	15.7	2.2	1.3
	9/28/77	30	151	7.1	257	249	15.2	2.2	1.3
	Average	32	154	7.1	259	254	15.4	2.2	1.3
Inter Speed 100% Load	9/26/77	23	179	10.9	313	307	8.8	1.3	1.1
	9/28/77	35	176	10.8	295	295	24.2	3.4	1.5
	Average	29	178	10.8	304	301	16.5	2.4	1.3
High Speed 2% Load	9/26/77	57	458	3.3	71	72	16.4	1.8	1.3
	9/28/77	55	399	3.3	68	70	15.9	1.5	1.2
	Average	56	429	3.3	70	71	16.2	1.6	1.2
High Speed 50% Load	9/26/77	27	212	8.0	307	298	23.9	3.8	1.6
	9/28/77	34	215	7.7	293	292	13.0	1.9	1.3
	Average	30	214	7.8	300	295	18.4	2.8	1.4
High Speed 100% Load	9/26/77	27	261	11.9	398	393	34.7	5.0	1.7
	9/28/77	42	290	11.9	380	377	20.3	3.3	1.5
	Average	35	276	11.9	389	385	27.5	4.2	1.6
Idle	9/26/77	63	160	2.9	98	98	5.5	1.3	1.1
	9/28/77	57	145	2.8	81	82	8.4	1.1	1.0
	Average	60	152	2.8	90	90	7.0	1.2	1.0

COMPARISON OF GASEOUS EMISSIONS

VEHICLE: Mercedes 240D FUEL: EM-241-F

					C.L.		DOAS Results		
Operating Condition	Date	HC, ppm	CO, ppm	CO_2, %	NO, ppm	NO_x, ppm	LCA, µg/l	LCO, µg/l	TIA
Inter. Speed 2% Load	9/30/77	53	161	2.3	57	59	2.9	1.7	1.2
	10/3/77	49	170	2.4	62	59	2.7	1.3	1.1
	Average	51	166	2.4	60	59	2.8	1.5	1.2
Inter. Speed 50% Load	9/30/77	38	145	6.3	251	256	2.6	1.6	1.2
	10/3/77	30	147	6.9	287	285	2.0	1.5	1.2
	Average	34	146	6.6	269	270	2.3	1.6	1.2
Inter Speed 100% Load	9/30/77	43	216	10.5	279	279	7.8	4.5	1.7
	10/3/77	25	210	11.7	317	310	2.3	1.7	1.2
	Average	34	213	11.1	298	294	5.0	3.1	1.4
High Speed 2% Load	9/30/77	52	335	3.3	75	77	4.3	2.2	1.3
	10/3/77	46	376	3.3	80	76	2.9	1.3	1.1
	Average	49	356	3.2	78	76	3.6	1.8	1.2
High Speed 50% Load	9/30/77	30	195	7.2	287	291	4.2	2.5	1.4
	10/3/77	32	221	7.5	310	307	2.6	1.6	1.2
	Average	31	208	7.4	298	299	3.4	2.0	1.3
High Speed 100% Load	9/30/77	28	307	11.3	342	347	5.2	3.7	1.6
	10/3/77	33	261	12.2	403	408	5.3	3.3	1.5
	Average	30	284	11.8	372	378	5.3	3.5	1.6
Idle	9/30/77	92	155	2.3	82	80	5.0	2.4	1.4
	10/3/77	77	155	2.8	90	87	3.3	1.2	1.1
	Average	84	155	2.6	86	84	4.2	1.8	1.2

COMPARISON OF GASEOUS EMISSIONS

VEHICLE: Mercedes 240 D FUEL: EM-242-F

					C.L.		DOAS Results		
Operating Condition	Date	HC, ppm	CO, ppm	CO_2, %	NO, ppm	NO_x, ppm	LCA, µg/l	LCO, µg/l	TIA
Inter. Speed 2% Load	10/5/77	62	314	2.8	66	62	3.6	1.8	1.2
	10/7/77	54	---	---	--	--	3.3	2.0	1.3
	Average	58	314	2.8	66	62	3.4	1.9	1.2
Inter. Speed 50% Load	10/5/77	37	149	7.0	280	278	2.7	2.0	1.3
	10/7/77	29	---	---	---	---	3.9	3.1	1.5
	Average	33	149	7.0	280	278	3.3	2.6	1.4
Inter. Speed 100% Load	10/5/77	31	213	11.5	315	323	3.5	2.3	1.4
	10/7/77	35	---	----	---	---	5.8	3.7	1.6
	Average	33	213	11.5	315	323	4.6	3.0	1.5
High Speed 2% Load	10/5/77	48	381	3.3	77	75	2.9	1.7	1.2
	10/7/77	46	---	---	--	--	2.7	2.1	1.3
	Average	47	381	3.3	77	75	2.8	1.9	1.2
High Speed 50% Load	10/5/77	30	210	7.4	308	303	2.4	1.7	1.2
	10/7/77	30	---	---	---	---	3.1	2.6	1.4
	Average	30	210	7.4	308	303	2.8	2.2	1.3
High Speed 100% Load	10/5/77	28	324	12.4	405	403	3.1	2.5	1.4
	10/7/77	31	---	----	---	---	4.9	4.8	1.7
	Average	30	324	12.4	405	403	4.0	3.6	1.6
Idle	10/5/77	79	166	2.8	86	88	3.1	1.1	1.0
	10/7/77	77	---	---	--	--	3.9	1.8	1.2
	Average	78	166	2.8	86	88	3.5	1.4	1.1

COMPARISON OF GASEOUS EMISSIONS

VEHICLE: VW Rabbit FUEL: EM-238-F

					C.L.		DOAS Results		
Operating Condition	Date	HC, ppm	CO, ppm	CO_2, %	NO, ppm	NO_x, ppm	LCA, µg/l	LCO, µg/l	TIA
Inter. Speed	8/26/77	172	333	2.1	36	45	13.4	7.7	1.9
0 Load	8/29/77	100	244	2.1	44	48	8.6	4.7	1.7
	Average	136	288	2.1	40	46	11.0	6.2	1.8
Inter. Speed	8/26/77	99	183	6.5	220	215	24.2	10.3	2.0
Mid Load	8/29/77	68	175	7.1	214	208	16.6	11.9	2.1
	Average	84	179	6.8	118	211	20.4	11.1	2.0
Inter. Speed	8/26/77	58	394	12.7	254	252	19.4	12.2	2.1
High Load	8/29/77	110	400	13.2	252	250	37.2	18.7	2.3
	Average	84	397	13.0	253	251	28.3	15.4	2.2
High Speed	8/26/77	47	230	2.3	73	79	2.6	2.4	1.4
0 Load	8/29/77	81	242	2.4	76	79	10.2	5.2	1.7
	Average	64	236	2.4	74	79	6.4	3.8	1.5
High Speed	8/26/77	108	310	7.8	318	304	22.9	11.5	2.1
Mid Load	8/29/77	133	298	7.9	296	283	24.4	11.7	2.1
	Average	120	304	7.8	307	293	23.6	11.6	2.1
High Speed	8/26/77	64	2408	13.3	307	305	23.4	13.3	2.1
High Load	8/29/77	53	2362	13.2	293	292	17.0	11.9	2.1
	Average	58	2385	13.2	300	298	20.2	12.6	2.1
Idle	8/26/77	243	374	2.3	78	80	11.2	5.0	1.7
	8/29/77	249	382	2.3	78	75	11.7	5.0	1.7
	Average	246	378	2.3	78	78	11.4	5.0	1.7

COMPARISON OF GASEOUS EMISSIONS

VEHICLE: VW Rabbit FUEL: EM-239-F

					C.L.		DOAS Results		
Operating Condition	Date	HC, ppm	CO, ppm	CO_2, %	NO, ppm	NO_x ppm	LCA, µg/l	LCO, µg/l	TIA
Inter. Speed	8/22/77	195	324	2.0	32	35	10.8	6.4	1.8
0 Load	8/24/77	81	290	2.1	46	46	6.3	4.3	1.6
	Average	138	307	2.0	39	40	8.6	5.4	1.7
Inter. Speed	8/22/77	109	182	6.0	179	162	13.9	7.7	1.9
Mid Load	8/24/77	111	182	6.4	196	195	13.9	7.2	1.9
	Average	110	182	6.2	188	178	1.39	7.4	1.9
Inter. Speed	8/22/77	97	237	11.2	230	216	18.2	11.5	2.1
High Load	8/24/77	175	299	12.2	240	240	33.8	15.8	2.2
	Average	136	268	11.7	235	228	26.0	13.6	2.2
High Speed	8/22/77	65	221	2.3	74	72	3.6	3.0	1.5
0 Load	8/24/77	79	251	2.4	69	78	7.8	3.1	1.5
	Average	72	236	2.4	72	75	5.7	3.0	1.5
High Speed	8/22/77	183	304	7.2	267	238	31.3	16.4	2.2
Mid Load	8/24/77	176	325	7.7	288	273	25.2	10.6	2.0
	Average	180	314	7.4	278	256	28.4	13.5	2.1
High Speed	8/22/77	103	367	11.2	285	274	17.8	13.8	2.1
High Load	8/24/77	83	2170	13.0	271	270	13.9	9.4	2.0
	Average	93	1268	12.1	278	272	15.8	11.6	2.0
Idle	8/22/77	328	431	2.4	73	65	11.5	6.2	1.8
	8/24/77	300	407	2.3	72	75	12.2	5.1	1.7
	Average	314	419	2.4	72	70	11.8	5.6	1.8

COMPARISON OF GASEOUS EMISSIONS

VEHICLE: VW Rabbit FUEL: EM-240-F

					C.L.		DOAS Results		
Operating Condition	Date	HC, ppm	CO, ppm	CO_2, %	NO, ppm	NO_x, ppm	LCA, µg/l	LCO, µg/l	TIA
Inter. Speed 0 Load	8/31/77	95	335	2.1	39	48	28.8	4.0	1.6
	9/02/77	59	335	2.1	54	62	23.1	3.3	1.5
	Average	77	335	2.1	46	55	26.0	3.6	1.6
Inter. Speed Mid Load	8/31/77	71	176	6.6	231	229	63.4	7.1	1.9
	9/02/77	55	179	6.4	261	252	43.5	3.9	1.6
	Average	63	178	6.5	246	240	53.4	6.0	1.8
Inter. Speed High Load	8/31/77	68	201	10.9	256	254	77.9	8.1	1.9
	9/02/77	101	224	11.7	291	288	78.2	9.4	2.0
	Average	84	212	11.3	274	271	78.0	8.8	2.0
High Speed 0 Load	8/31/77	415	352	2.4	69	70	68.5	4.9	1.7
	9/02/77	384	356	2.4	70	74	70.4	4.9	1.7
	Average	400	354	2.4	70	72	69.4	4.9	1.7
High Speed Mid Load	8/31/77	181	417	7.7	289	263	118.7	10.6	2.0
	9/02/77	171	440	7.9	299	262	127.6	9.2	2.0
	Average	176	428	7.8	294	262	123.2	9.9	2.0
High Speed High Load	8/31/77	75	374	12.2	313	307	72.7	10.8	2.0
	9/02/77	84	351	11.8	325	315	74.2	11.7	2.0
	Average	80	362	12.0	319	311	73.4	11.2	2.0
Idle	8/31/77	332	322	2.4	84	84	34.5	3.3	1.5
	9/02/77	253	312	2.3	89	88	28.8	3.0	1.5
	Average	292	317	2.4	86	86	31.6	3.2	1.5

SUMMARY OF GASEOUS EMISSIONS

VEHICLE: VW Rabbit FUEL: EM-241-F

Operating Condition	Date	HC, ppm	CO, ppm	CO_2, %	C.L. NO, ppm	C.L. NO_x, ppm	DOAS Results LCA, µg/l	DOAS Results LCO, µg/l	DOAS Results TIA
Inter. Speed 0 Load	9/7/77	148	381	2.1	58	54	24.7	14.0	2.2
	9/9/77	155	450	2.2	52	53	30.3	15.8	2.2
	Average	152	416	2.2	55	54	27.5	14.9	2.2
Inter. Speed Mid Load	9/7/77	95	192	6.4	220	209	33.8	17.2	2.2
	9/9/77	55	193	6.5	212	213	29.7	14.8	2.2
	Average	75	192	6.4	216	211	31.8	16.0	2.2
Inter. Speed High Load	9/7/77	92	1147	13.5	256	254	54.7	31.6	2.5
	9/9/77	79	1786	13.9	254	246	43.8	24.6	2.4
	Average	86	1466	13.7	255	250	49.2	28.1	2.4
High Speed 0 Load	9/7/77	104	364	2.5	70	73	14.7	6.9	1.8
	9/9/77	54	334	2.4	74	75	20.1	10.1	2.0
	Average	79	349	2.4	72	74	17.4	8.5	1.9
High Speed Mid Load	9/7/77	120	276	7.7	323	308	37.6	18.8	2.3
	9/9/77	121	307	8.0	312	300	72.6	30.9	2.5
	Average	120	292	7.8	318	304	55.1	24.8	2.4
High Speed High Load	9/7/77	83	1738	12.9	327	322	37.8	26.2	2.4
	9/9/77	108	337	13.2	312	309	32.5	16.8	2.2
	Average	96	1038	13.0	320	316	35.2	21.5	2.3
Idle	9/7/77	717	635	2.3	71	70	51.5	17.6	2.3
	9/9/77	533	767	2.4	76	77	47.3	15.2	2.2
	Average	625	701	2.4	74	74	49.4	16.4	2.2

SUMMARY OF GASEOUS EMISSIONS

VEHICLE: VW Rabbit FUEL: EM-242-F

					C.L.		DOAS Results		
Operating Condition	Date	HC, ppm	CO, ppm	CO_2, %	NO, ppm	NO_x, ppm	LCA, µg/l	LCO, µg/l	TIA
Inter. Speed 0 Load	9/12/77	73	273	2.1	48	55	8.1	4.2	1.6
	9/14/77	62	227	2.1	59	62	3.5	2.5	1.4
	Average	68	250	2.1	54	58	5.8	3.4	1.5
Inter. Speed Mid Load	9/12/77	96	202	6.9	242	242	15.8	6.2	1.8
	9/14/77	60	167	6.0	234	223	6.3	3.4	1.5
	Average	78	184	6.5	238	232	11.0	4.8	1.6
Inter. Speed High Load	9/12/77	48	538	12.9	255	255	18.0	9.4	2.0
	9/14/77	72	362	12.5	265	261	13.8	7.3	1.9
	Average	60	450	12.7	260	258	15.9	8.4	2.0
High Speed 0 Load	9/12/77	35	241	2.4	105	99	5.3	3.1	1.5
	9/14/77	51	219	2.4	103	94	4.1	2.3	1.3
	Average	43	230	2.4	104	96	4.7	2.7	1.4
High Speed Mid Load	9/12/77	113	343	7.7	342	313	21.1	8.7	1.9
	9/14/77	152	341	7.6	330	301	17.3	7.4	1.9
	Average	132	342	7.6	336	307	19.2	8.0	1.9
High Speed High Load	9/12/77	61	3743	13.9	292	289	16.5	8.8	1.9
	9/14/77	56	925	12.7	296	292	12.8	8.5	1.9
	Average	58	2334	13.3	294	290	14.6	8.6	1.9
Idle	9/12/77	205	385	2.3	81	84	9.2	4.1	1.6
	9/14/77	161	321	2.2	74	79	3.1	1.9	1.3
	Average	183	353	2.2	78	82	6.2	3.0	1.4

ALDEHYDE AND INDIVIDUAL HYDROCARBON CONCENTRATIONS MEASURED DURING STEADY-STATE ODOR RUNS, MERCEDES 240D

Fuel: EM-238-F

Compound, units	Concentration by Operating Condition						
	1800 rpm			3000 rpm			
	2% load	50% load	100% load	2% load	50% load	100% load	Idle
Formaldehyde, ppm	0.8	0	0.4	0.1	0.9	0.5	0.3
Acetaldehyde, ppm	1.2	0	0.6	0.2	0.3	0.7	1.0
[a]Acetone, ppm	0.9	0	0.4	0.2	0.2	0.4	0.6
Isobutyraldehyde, ppm	0	0	0	0	0	0	0
Crotonaldehyde, ppm	2.1	0	2.1	0.1	1.0	3.2	2.1
Hexanal, ppm	0.2	0.1	0.1	0.2	0.1	0.2	0.2
Benzaldehyde, ppm	2.4	2.1	2.0	3.2	2.2	2.2	1.8
Total Aldehydes, ppm	7.6	2.2	5.6	4.0	4.7	7.2	6.0
Methane, ppmC	6.2	3.9	3.9	7.5	4.2	3.0	9.1
Ethylene, ppmC	7.5	6.1	6.7	11.2	5.3	5.7	14.4
Ethane, ppmC	0.4	0.3	0.2	0.5	0.2	0	0.9
Acetylene, ppmC	2.4	2.2	2.8	5.1	3.0	3.4	4.5
Propane, ppmC	0.1	0.1	0	0.1	0	0	0.2
Propylene, ppmC	2.9	1.8	1.8	2.8	1.2	1.1	4.5
Benzene, ppmC	1.3	1.5	2.0	2.8	1.5	1.7	3.4
Toluene, ppmC	0.1	0.1	0.1	0.1	0.1	0	0.4
Non-Methane, ppmC	14.7	12.1	13.6	22.6	11.3	11.9	28.3

Fuel: EM-239-F

Compound, units	Concentration by Operating Condition						
	1800 rpm			3000 rpm			
	2% load	50% load	100% load	2% load	50% load	100% load	Idle
Formaldehyde, ppm	1.4	0.9	1.6	1.5	0	0.6	2.2
Acetaldehyde, ppm	0.6	1.2	0.8	0.7	0.7	0	1.9
[a]Acetone, ppm	0.3	0.8	0.3	0.5	0.5	0	1.2
Isobutyraldehyde, ppm	1.1	1.4	1.8	1.5	1.6	0.9	1.7
Crotonaldehyde, ppm	2.0	7.1	2.6	2.8	3.7	1.0	5.7
Hexanal, ppm	0.4	0.4	0.4	0.6	0.4	0.2	0.4
Benzaldehyde ,ppm	3.6	3.2	5.5	4.8	2.5	2.5	3.2
Total Aldehydes, ppm	9.4	15.0	13.0	12.4	9.4	5.2	16.3
Methane, ppmC	6.6	3.9	4.7	7.6	3.4	2.3	8.7
Ethylene, ppmC	11.5	6.8	7.7	12.4	5.3	5.7	16.2
Ethane, ppmC	0.7	0.3	3.1	0.5	0.2	0	1.0
Acetylene, ppmC	3.4	2.4	0	5.3	2.7	3.2	5.2
Propane, ppmC	0.1	0	0	0.1	0	0	0.3
Propylene, ppmC	4.2	2.1	2.1	3.3	1.3	1.2	5.6
Benzene, ppmC	2.3	1.8	2.7	3.5	1.7	1.6	4.0
Toluene, ppmC	0.8	0.1	0.2	0.7	0.1	0.1	1.1
Non-Methane, ppmC	23.0	13.5	15.8	25.8	11.3	11.8	33.4

[a] includes acetone, acrolein, and propanal

ALDEHYDE AND INDIVIDUAL HYDROCARBON CONCENTRATIONS MEASURED DURING STEADY-STATE ODOR RUNS, MERCEDES 240D

Fuel: EM-240-F

Compound, units	Concentration by Operating Condition						
	1800 rpm			3000 rpm			
	2% load	50% load	100% load	2% load	50% load	100% load	Idle
Formaldehyde, ppm	0.34	0.41	1.19	1.65	0.26	1.15	1.71
Acetaldehyde, ppm	0.16	0	0.84	0.95	0	0.98	1.05
[a]Acetone, ppm	0.10	0	0.41	0.30	0	0.34	0.53
Isobutyraldehyde, ppm	0	0.45	0.38	0.17	0.12	0.25	0.33
Crotonaldehyde, ppm	0.54	1.42	2.96	1.34	0.24	2.50	1.14
Hexanal, ppm	0	0.13	0	0	0	0.12	0.06
Benzaldehyde, ppm	2.43	2.53	0.50	3.59	0.16	1.08	0.92
Total Aldehydes, ppm	3.57	4.94	6.28	8.00	0.78	6.42	5.74
Methane, ppmC	6.2	3.9	4.4	10.4	5.0	5.5	6.7
Ethylene, ppmC	9.0	8.4	6.7	14.6	6.1	7.7	11.5
Ethane, ppmC	0.4	0.2	0.2	0.7	0.3	0.2	0.7
Acetylene, ppmC	2.8	2.5	2.8	7.1	3.6	4.6	3.8
Propane, ppmC	0	0	0	0.1	0.1	0	0.1
Propylene, ppmC	2.7	2.6	1.9	3.4	1.3	1.5	3.6
Benzene, ppmC	2.0	1.9	2.3	4.8	2.0	2.5	3.4
Toluene, ppmC	0.1	0.1	0.1	0.5	0	0.1	0.6
Non-Methane, ppmC	17.0	15.7	14.0	31.2	13.4	16.6	23.7

Fuel: EM-241-F

Compound, units	Concentration by Operating Condition						
	1800 rpm			3000 rpm			
	2% load	50% load	100% load	2% load	50% load	100% load	Idle
Formaldehyde, ppm	1.54	0	0.74	1.07	1.09	0.99	1.16
Acetaldehyde, ppm	1.85	0.13	0.98	1.30	0.30	0.40	1.57
[a]Acetone, ppm	0.70	0	0.34	0.62	0	0.03	----
Isobutyraldehyde, ppm	0.29	0.08	0.49	0.08	0	0	1.00
Crotonaldehyde, ppm	1.53	1.17	1.42	1.27	1.20	1.67	1.20
Hexanal, ppm	0	0	0	0	0.06	0.07	----
Benzaldehyde, ppm	0.90	1.09	0.80	1.89	1.20	2.03	1.13
Total Aldehydes, ppm	6.81	2.47	4.77	6.23	3.85	5.19	6.06
Methane, ppmC	5.3	3.6	5.1	8.3	4.3	4.1	7.7
Ethylene, ppmC	8.1	7.5	6.6	10.8	4.8	6.6	15.9
Ethane, ppmC	0.3	0.2	0.2	0.5	0.2	0	1.0
Acetylene, ppmC	2.6	2.5	3.2	5.7	2.9	4.3	5.2
Propane, ppmC	0.1	0	0	0	0	0	0.2
Propylene, ppmC	2.5	2.3	1.8	2.3	1.0	1.2	5.4
Benzene, ppmC	1.9	1.8	2.7	3.6	1.6	2.2	4.2
Toluene, ppmC	0.1	0.1	0.3	0.4	0.1	0.1	0.7
Non-Methane, ppmC	15.6	14.4	14.8	23.3	10.6	14.4	32.6

[a] includes acetone, acrolein, and propanal

ALDEHYDE AND INDIVIDUAL HYDROCARBON CONCENTRATIONS
MEASURED DURING STEADY-STATE ODOR RUNS, MERCEDES 240D

Fuel: EM-242-F

	Concentration by Operating Condition						
	1800 rpm			3000 rpm			
Compound, units	2% load	50% load	100% load	2% load	50% load	100% load	Idle
Formaldehyde, ppm	1.28	0.25	0.76	1.86	0	0.63	1.93
Acetaldehyde, ppm	1.41	0	0.36	1.29	0.05	0.46	1.53
[a]Acetone, ppm	0.56	0	0	0.58	0.09	0.13	0.59
Isobutyraldehyde, ppm	0.16	0.06	0.06	0.19	0.13	0.15	0.12
Crotonaldehyde, ppm	0.91	0.92	0.76	1.04	0.33	1.03	1.21
Hexanal, ppm	0	0	0.11	0	0	0	0.16
Benzaldehyde, ppm	0.66	0.36	0.64	0.95	0.48	0.94	1.06
Total Aldehydes, ppm	4.98	1.59	2.69	5.91	1.08	3.34	6.60
Methane, ppmC	8.5	3.6	4.6	8.4	4.9	3.9	8.1
Ethylene, ppmC	14.4	4.3	6.0	11.1	5.9	6.2	14.1
Ethane, ppmC	0.6	0.2	0.2	0.6	0.2	0	0.9
Acetylene, ppmC	5.6	1.8	2.8	5.7	3.8	4.2	4.9
Propane, ppmC	0.1	0.1	0	0.1	0	0	0.2
Propylene, ppmC	4.4	1.1	1.6	2.4	1.2	1.1	4.6
Benzene, ppmC	3.4	1.5	2.2	3.4	2.3	2.1	4.1
Toluene, ppmC	0.5	0.1	0.1	0.1	0.1	0.1	0.7
Non-Methane, ppmC	29.0	9.1	12.9	23.4	13.5	13.7	29.5

[a] includes acetone, acrolein, and propanal

ALDEHYDE AND INDIVIDUAL HYDROCARBON CONCENTRATIONS MEASURED DURING STEADY-STATE ODOR RUNS, VW RABBIT DIESEL

Fuel: EM-238-F

	Concentration by Operating Condition						
	2020 rpm			3360 rpm			
Compound, units	2% load	50% load	100% load	2% load	50% load	100% load	Idle
Formaldehyde, ppm	9.5	1.8	2.1	1.6	1.1	1.4	16.5
Acetaldehyde, ppm	5.4	1.3	1.6	1.2	0.6	1.5	8.3
[a]Acetone, ppm	1.8	0.8	0.5	0.7	0.1	0.3	2.7
Isobutyraldehyde, ppm	0.8	0.1	0	0.2	0	0	0.8
Crotonaldehyde, ppm	1.1	1.4	0.8	2.1	0.5	2.0	2.5
Hexanal, ppm	0.7	0	0.3	0	0	0.3	0
Benzaldehyde, ppm	4.0	11.2	4.5	2.8	0.9	10.1	9.2
Total Aldehydes, ppm	23.3	16.6	9.8	8.6	3.2	15.6	40.0
Methane, ppmC	4.6	0	0.4	0.6	5.1	3.8	2.9
Ethylene, ppmC	35.0	12.5	13.9	8.6	19.7	18.3	26.2
Ethane, ppmC	0.6	0.1	0	0	0.6	0.3	0.4
Acetylene, ppmC	6.1	2.7	3.6	2.3	7.1	6.5	4.4
Propane, ppmC	0.1	0	0	0	0	0	0
Propylene, ppmC	12.3	4.1	3.9	2.4	4.9	4.9	8.5
Benzene, ppmC	3.6	1.8	2.3	0.7	4.1	3.6	3.0
Toluene, ppmC	1.1	0	0	0	0	0	0.5
Non-Methane, ppmC	58.8	21.2	23.7	14.0	36.4	33.6	43.0

Fuel: EM-239-F

	Concentration by Operating Condition						
	2020 rpm			3360 rpm			
Compound, units	2% load	50% load	100% load	2% load	50% load	100% load	Idle
Formaldehyde, ppm	1.8	0.5	1.5	0	2.0	0.7	12.8
Acetaldehyde, ppm	1.0	0.2	2.1	0	1.4	0.6	3.4
[a]Acetone, ppm	0.9	0.2	1.4	0	1.6	0.4	2.3
Isobutyraldehyde, ppm	0.2	0.2	0.7	0	0.4	0	1.1
Crotonaldehyde, ppm	2.1	1.9	4.4	0.6	2.7	2.6	3.0
Hexanal, ppm	0	0.3	0	0	0	0	0.8
Benzaldehyde, ppm	1.8	2.3	3.3	1.4	2.2	2.3	2.1
Total Aldehydes, ppm	7.8	5.6	13.4	2.0	10.3	6.6	25.5
Methane, ppmC	2.7	1.8	1.8	2.6	9.2	8.8	5.4
Ethylene, ppmC	15.5	12.2	11.6	8.6	32.5	15.0	30.0
Ethane, ppmC	0.3	0.3	0.2	0.3	1.5	0.6	0.8
Acetylene, ppmC	2.3	2.8	2.2	2.0	7.6	5.6	4.1
Propane, ppmC	0.1	0	0.6	0	0.1	0	0.2
Propylene, ppmC	5.2	4.1	3.5	2.6	9.4	2.2	10.0
Benzene, ppmC	1.5	2.0	2.1	1.1	5.7	3.6	2.4
Toluene, ppmC	0	0	0	0	0	0	0.2
Non-Methane, ppmC	24.9	21.4	20.2	14.6	56.8	27.0	47.7

[a] includes acetone, acrolein, and propanal

MEASURED DURING STEADY-STATE ODOR RUNS, VW RABBIT DIESEL

Fuel: EM-240-F

Compound, units	Concentration by Operating Condition						
	2020 rpm			3360 rpm			
	2% load	50% load	100% load	2% load	50% load	100% load	Idle
Formaldehyde, ppm	2.1	0.9	2.1	0.8	0.7	0	0.9
Acetaldehyde, ppm	1.3	0.1	1.1	0	0.6	0	0.8
[a]Acetone, ppm	0.7	0.1	0.6	0	0.5	0	0.3
Isobutyraldehyde, ppm	0.3	0	0.3	0	0.3	0	0
Crotonaldehyde, ppm	4.1	1.5	2.4	0.4	2.2	9.2	0.5
Hexanal, ppm	0.5	0	0	0	0	0	0
Benzaldehyde, ppm	3.8	3.1	3.1	0.9	4.0	5.6	1.4
Total Aldehydes, ppm	12.8	5.7	9.6	2.1	8.3	14.8	3.9
Methane, ppmC	0.5	0	0	2.1	13.8	4.6	0.2
Ethylene, ppmC	21.1	9.0	14.7	24.6	40.0	20.9	20.6
Ethane, ppmC	0.1	0	0	1.0	1.9	0.3	0.1
Acetylene, ppmC	4.4	4.0	4.8	5.9	19.3	8.4	3.5
Propane, ppmC	0	0	0	0	0.2	0.1	0
Propylene, ppmC	6.8	2.1	4.6	8.6	8.3	3.9	6.8
Benzene, ppmC	1.8	2.6	3.6	4.7	9.4	4.8	1.9
Toluene, ppmC	0.7	0.2	0.7	0.7	1.8	0.7	0.6
Non-Methane, ppmC	34.9	17.9	28.4	45.5	80.9	39.1	33.5

Fuel: EM-241-F

Compound, units	Concentration by Operating Condition						
	2020 rpm			3360 rpm			
	2% load	50% load	100% load	2% load	50% load	100% load	Idle
Formaldehyde, ppm	7.6	2.2	0	4.2	2.6	0.8	26.4
Acetaldehyde, ppm	3.8	2.3	0	2.0	1.0	0.5	7.2
[a]Acetone, ppm	2.0	4.0	0	0.8	0.4	0.1	2.8
Isobutyraldehyde, ppm	1.1	2.3	0	0.4	0.2	1.2	2.8
Crotonaldehyde, ppm	4.9	6.4	0.1	3.0	2.0	2.6	3.8
Hexanal, ppm	0	0.4	0	0	0.3	0.4	1.4
Benzaldehyde, ppm	2.0	6.6	1.1	1.8	1.6	4.8	8.2
Total Aldehydes, ppm	21.4	24.2	2.2	12.2	8.1	10.4	52.6
Methane, ppmC	6.8	4.0	7.6	5.0	11.7	9.5	10.0
Ethylene, ppmC	19.8	13.8	12.7	10.2	27.0	11.1	49.4
Ethane, ppmC	0.4	0.3	0.3	0.3	1.3	0.4	1.0
Acetylene, ppmC	4.4	3.3	6.2	3.0	9.3	6.0	8.2
Propane, ppmC	0.1	0.1	0	0.1	0.2	0	0.2
Propylene, ppmC	6.2	4.5	2.8	2.7	8.6	1.8	16.5
Benzene, ppmC	1.6	1.9	3.1	1.0	5.0	2.7	7.0
Toluene, ppmC	0.4	0.4	0	0.3	0.9	0	1.7
Non-Methane, ppmC	32.9	24.3	25.1	17.6	52.3	22.0	84.0

[a] includes acetone, acrolein, and propanal

ALDEHYDE AND INDIVIDUAL HYDROCARBON CONCENTRATIONS
MEASURED DURING STEADY-STATE ODOR RUNS, VW RABBIT DIESEL

Fuel: EM-242-F

Compound, units	Concentration by Operating Condition						
	2020 rpm			3360 rpm			
	2% load	50% load	100% load	2% load	50% load	100% load	Idle
Formaldehyde, ppm	3.9	1.4	1.8	0.6	1.9	0.7	16.3
Acetaldehyde, ppm	1.3	0.9	2.0	0.6	0.9	0	6.8
[a]Acetone, ppm	1.0	0.5	2.9	0.1	0.7	0	3.9
Isobutyraldehyde, ppm	1.1	1.0	1.1	0.7	1.1	0.1	2.4
Crotonaldehyde, ppm	0	0.2	0	0	0	0	0.2
Hexanal, ppm	0.4	0.4	0.3	0.3	0.3	0.3	0.7
Benzaldehyde, ppm	5.2	4.1	5.3	2.3	4.2	4.1	3.6
Total Aldehydes, ppm	12.9	8.5	13.4	4.6	9.1	5.2	33.9
Methane, ppmC	5.8	9.7	7.8	5.4	15.7	14.9	6.4
Ethylene, ppmC	17.4	16.0	14.1	8.2	31.7	16.2	26.7
Ethane, ppmC	0.4	0.9	0.4	0.3	1.8	0.6	0.5
Acetylene, ppmC	3.2	6.1	5.3	3.1	11.8	9.6	4.3
Propane, ppmC	0.1	0.1	0	0.1	0.2	0	0.1
Propylene, ppmC	5.6	4.2	3.3	1.9	8.0	1.8	8.7
Benzene, ppmC	1.5	4.7	3.7	1.2	7.2	2.9	2.0
Toluene, ppmC	0.4	0.7	0.2	0.2	1.4	0	0.6
Non-Methane, ppmC	28.6	32.7	27.0	15.0	62.1	31.1	42.9

[a] includes acetone, acrolein, and propanal

MERCEDES 240D GASEOUS EMISSIONS - FUEL SPECIFIC BASIS

Fuel	Operating Schedule	VAR. 40 HC g/kg fuel	VAR. 41 CO g/kg fuel	VAR. 42 NO_x g/kg fuel	VAR. 43 CO_2 g/kg fuel	VAR. 45 formaldehyde mg/kg fuel	VAR. 46 acetaldehyde mg/kg fuel	VAR. 47 acetone[a] mg/kg fuel
EM-238-F	FTP 3-Bag	1.67	7.95	10.9	3150.	66.	14.	50.
	FTPC	1.88	8.04	10.9	3160.	80.	12.	35.
	FTPH	1.35	8.09	10.9	3160.	57.	16.	64.
	CFDS	1.52	6.56	14.1	3160.	37.	5.7	13.
	FET	1.10	6.44	12.5	3170.	16.	5.3	37.
	NYCC	2.39	9.90	10.5	3160.	100.	28.	330.
	Idle	4.27	12.7	11.3	3130.	130.	6.92	100.
	50 KPH	2.04	6.89	12.0	3160.	28.	3.8	21.
	85 KPH	1.47	6.62	15.4	3160.	26.	1.5	11.
EM-239-F	FTP 3-Bag	2.62	8.82	10.9	3170.	69.	9.5	43.
	FTPC	2.75	8.65	10.6	3170.	75.	8.8	6.2
	FTPH	1.90	8.77	11.7	3170.	67.	10.	98.
	CFDS	1.31	7.36	11.8	3180.	31.	0.0	0.0
	FET	1.09	7.26	13.2	3180.	60.	0.0	20.
	NYCC	2.22	10.9	10.6	3170.	42.	0.0	0.0
	Idle	4.30	12.7	11.7	3140.	0.0	0.0	0.0
	50 KPH	1.44	6.46	12.0	3160.	0.0	0.0	0.0
	85 KPH	1.08	7.41	13.9	3160.	9.6	0.0	0.0
EM-240-F	FTP 3-Bag	1.31	8.31	10.6	3320.	36.	1.3	4.5
	FTPC	1.39	8.09	10.3	3320.	36.	2.0	10.
	FTPH	1.39	8.95	11.1	3320.	37.	0.73	0.0
	CFDS	0.99	7.42	11.4	3320.	48.	7.6	20.
	FET	0.71	7.26	12.2	3330.	65.	11.	25.
	NYCC	1.26	10.9	11.0	3310.	4.0	0.0	61.
	Idle	2.50	11.1	11.7	3300.	0.0	0.0	68.5
	50 KPH	1.12	7.00	11.5	3330.	23.	0.0	21.
	85 KPH	0.92	7.34	12.8	3320.	15.	1.6	5.9
EM-241-F	FTP 3-Bag	2.48	8.79	10.9	3100.	87.	16.	32.
	FTPC	2.86	8.94	10.6	3100.	80.	13.	19.
	FTPH	1.96	8.89	11.1	3100.	94.	18.	43.
	CFDS	1.18	7.09	12.3	3100.	16.	6.1	28.
	FET	0.83	6.61	13.2	3110.	20.	0.0	12.
	NYCC	2.50	11.7	10.6	3090.	0.0	0.0	36.
	Idle	5.27	13.5	13.2	3090.	88.3	14.	110.
	50 KPH	1.42	7.10	11.6	3100	0.0	0.0	2.1
	85 KPH	1.02	6.77	11.8	3120.	14.	0.0	5.4
EM-242-F	FTP 3-Bag	1.54	8.72	10.9	3220.	69.	7.3	15.
	FTPC	1.71	8.69	10.6	3220.	61.	0.0	3.9
	FTPH	1.38	8.98	11.3	3220.	79.	14.	26.
	CFDS	1.23	7.91	12.5	3220.	21.	0.0	0.0
	FET	0.93	7.61	12.8	3210.	20.	0.0	0.0
	NYCC	1.87	11.4	11.3	3200.	29.	0.0	0.0
	Idle	2.93	12.6	11.9	3200.	80.2	0.0	0.0
	50 KPH	1.56	6.48	11.7	3220.	25.	0.0	0.0
	85 KPH	1.01	8.08	13.7	3210.	28.	0.0	0.0

[a] plus salicylaldehyde

MERCEDES 240D GASEOUS EMISSIONS - FUEL SPECIFIC BASIS (CONT'D)

Fuel	Operating Schedule	VAR. 48 isobutyraldehyde mg/kg fuel	VAR. 49 crotonal mg/kg fuel	VAR. 50 hexanal mg/kg fuel	VAR. 51 benzaldehyde mg/kg fuel	VAR. 52 o-cresol,[a] mg/kg fuel	VAR. 53 p-cresol, mg/kg fuel	VAR. 54 2,4-xylenol,[b] mg/kg fuel	VAR. 55 2,3-xylenol,[c] mg/kg fuel
EM-238-F	FTP 3-Bag	7.8	56.	10.	31.				
	FTPC	9.9	62.	11.	38.				
	FTPH	6.3	54.	10.	27.				
	CFDS	11.3	19.	5.2	49.				
	FET	2.0	37.	2.4	55.				
	NYCC	33.	220.	20.	0.0				
	Idle	10.4	219.	173.	0.0	0.0	0.0	0.0	0.0
	50 KPH	11.	82.	6.9	31.	0.0	0.0	0.0	0.0
	85 KPH	4.6	29.	8.4	8.8	0.59	0.55	0.0	0.0
EM-239-F	FTP 3-Bag	8.3	51.	17.	0.0				
	FTPC	0.0	48.	26.	0.0				
	FTPH	20.	54.	9.2	0.0				
	CFDS	0.0	190.	6.9	0.0				
	FET	120.	51.	25.	24.				
	NYCC	240.	160.	0.0	0.0				
	Idle	0.0	220.	102.	0.0	0.0	0.0	0.0	0.0
	50 KPH	0.0	34.	13.	0.0	0.0	0.24	0.0	0.0
	85 KPH	0.0	20.	0.0	0.0	0.47	0.43	0.0	0.0
EM-240-F	FTP 3-Bag	42.	57.	19.	74.				
	FTPC	20.	57.	25.	71.				
	FTPH	62.	59.	15.	79.				
	CFDS	9.7	66.	8.7	16.				
	FET	7.8	280.	7.3	18.				
	NYCC	16.	150.	0.0	30.				
	Idle	19.6	156.	25.	39.1	0.0	0.69	0.0	0.0
	50 KPH	6.2	43.	31.	20.	0.0	0.27	0.0	0.0
	85 KPH	0.0	18.	7.2	9.0	0.0	0.39	0.0	0.0
EM-241-F	FTP 3-Bag	15.	46.	26.	74.				
	FTPC	14.	42.	27.	54.				
	FTPH	16.	50.	25.	93.				
	CFDS	6.2	210.	3.1	16.				
	FET	3.6	8.9	4.5	84.				
	NYCC	21.	110.	27.	110.				
	Idle	30.	109.	24.0	76.6	0.0	0.92	0.0	0.0
	50 KPH	7.8	33.	6.4	62.	0.0	0.50	0.0	0.0
	85 KPH	3.2	27.	2.7	6.8	0.0	0.44	0.0	0.0
EM-242-F	FTP 3-Bag	54.	44.	28.	1.0				
	FTPC	58.	32.	15.	0.0				
	FTPH	52.	55.	40.	1.9				
	CFDS	69.	19.	21.	0.0				
	FET	120.	16.	6.3	0.0				
	NYCC	410.	43.	0.0	0.0				
	Idle	611.	121.0	94.0	0.0	0.0	0.0	0.0	0.0
	50 KPH	120.	29.	0.0	0.0	0.0	0.0	0.0	0.0
	85 KPH	34.	5.0	0.0	0.0	0.34	0.57	0.0	0.0

[a] plus salicylaldehyde
[b] plus 2,5-xylenol
[c] plus 3,5-xylenol

VW RABBIT DIESEL GASEOUS EMISSIONS - FUEL SPECIFIC BASIS

Fuel	Operating Schedule	VAR. 40 HC g/kg fuel	VAR. 41 CO g/kg fuel	VAR. 42 NO_x g/kg fuel	VAR. 43 CO_2 g/kg fuel	VAR. 45 formaldehyde mg/kg fuel	VAR. 46 acetaldehyde mg/kg fuel	VAR. 47 acetone[a] mg/kg fuel
EM-238-F	FTP 3-Bag	3.73	10.2	12.2	3170.	120.	25.	110.
	FTPC	4.58	10.9	12.3	3140.	130.	30.	130.
	FTPH	3.48	9.79	12.2	3150.	120.	20.	100.
	CFDS	2.00	8.99	13.2	3170.	95.	20.	62.
	FET	2.99	8.71	14.4	3160.	79.	4.1	54.
	NYCC	7.58	15.0	11.3	3140.	330.	18.	190.
	Idle	20.2	39.4	12.7	3040.	560.	120.	360.
	50 KPH	3.44	9.29	10.7	3160.	180.	23.	180.
	85 KPH	2.13	8.78	14.6	3160.	51.	6.9	43.
EM-239-F	FTP 3-Bag	4.23	10.8	13.8	3170.	110.	8.3	23.
	FTPC	5.61	11.4	13.0	3170.	120.	18.	40.
	FTPH	3.19	10.3	13.4	3170.	98.	0.0	9.8
	CFDS	2.89	10.1	12.0	3150.	26.	0.0	7.0
	FET	2.62	9.96	14.9	3170.	58.	0.0	0.0
	NYCC	5.45	16.0	13.5	3150.	120.	0.0	0.0
	Idle	18.2	35.2	13.8	3100.	1100.	0.0	0.0
	50 KPH	2.34	7.68	11.3	3170.	57.	0.0	0.0
	85 KPH	2.71	9.74	15.4	3160.	38.	3.0	24.
EM-240-F	FTP 3-Bag	3.69	12.0	12.4	3300.	87.	8.9	10.
	FTPC	4.96	12.0	12.0	3310.	95.	14.	13.
	FTPH	3.40	12.2	12.7	3310.	82.	4.3	7.5
	CFDS	3.06	10.7	13.0	3310.	87.	7.4	9.2
	FET	4.09	12.5	13.1	3300.	60.	6.3	16.0
	NYCC	4.87	17.4	11.6	3290.	190.	30.	0.0
	Idle	9.80	28.8	15.6	3240.	360.	21.	39.
	50 KPH	1.82	10.6	11.3	3320.	66.	14.	34.
	85 KPH	3.61	12.8	23.3	3300.	61.	11.	12.
EM-241-F	FTP 3-Bag	13.4	15.0	10.9	3050.	360.	90.	160.
	FTPC	20.2	16.7	10.6	3030.	410.	110.	200.
	FTPH	7.40	14.4	11.9	3080.	330.	80.	130.
	CFDS	4.63	9.95	13.2	3100.	88.	10.	21.
	FET	3.78	8.57	13.1	3100.	35.	5.0	16.
	NYCC	17.0	23.9	11.2	3000.	140.	0.0	32.
	Idle	38.6	62.	12.2	2900.	850.	210.	200.
	50 KPH	33.5	29.0	9.47	3000.	630.	140.	100.
	85 KPH	5.15	8.50	13.6	3090.	85.	15.	22.
EM-242-F	FTP 3-Bag	4.09	10.6	12.9	3210.	130.	18.	33.
	FTPC	5.15	11.3	12.5	3210.	160.	40.	48.
	FTPH	2.87	9.82	13.1	3210.	96.	0.0	19.
	CFDS	2.36	8.98	13.5	3220.	43.	0.0	0.0
	FET	2.81	10.0	14.8	3220.	33.	0.0	0.0
	NYCC	5.11	13.2	12.3	3210.	55.	0.0	0.0
	Idle	17.8	33.1	13.3	3120.	770.	280.	380.
	50 KPH	2.38	6.46	12.9	3230.	110.	8.2	44.
	85 KPH	2.12	9.28	15.9	3210.	40.	0.0	8.2

[a] plus salicylaldehyde

VW RABBIT DIESEL GASEOUS EMISSIONS - FUEL SPECIFIC BASIS (CONT'D)

Fuel	Operating Schedule	VAR. 48 isobutyr-aldehyde mg/kg fuel	VAR. 49 crotonal mg/kf fuel	VAR. 50 hexanal mg/kg fuel	VAR. 51 benz-aldehyde mg/kg fuel	VAR. 52 o-cresol,[a] mg/kg fuel	VAR. 53 p-cresol, mg/kg fuel	VAR. 54 2,4-xylenol,[b] mg/kg fuel	VAR. 55 2,3-xylenol,[c] mg/kg fuel
EM-238-F	FTP 3-Bag	15.	130.	81.	110.				
	FTPC	16.	140.	95.	160.				
	FTPH	15.	120.	70.	72.				
	CFDS	420.	420.	520.	520.				
	FET	18.	71.	26.	100.				
	NYCC	140.	410.	99.	100.				
	Idle	82.	390.	120.	740.	0.0	0.96	0.0	0.0
	50 KPH	19.	83.	19.	190.	0.89	1.8	0.0	0.48
	85 KPH	40.	32.	8.5	43.	0.93	0.96	0.0	0.0
EM-239-F	FTP 3-Bag	28.	78.	18.	5.9				
	FTPC	24.	92.	26.	0.0				
	FTPH	30.	68.	11.	11.				
	CFDS	0.0	650.	79.	0.0				
	FET	0.0	210.	21.	0.0				
	NYCC	110.	830.	0.0	0.0				
	Idle	1100.	1100.	0.0	0.0	0.0	0.62	0.0	0.0
	50 KPH	0.0	160.	37.	0.0	0.0	0.77	0.0	0.0
	85 KPH	30.	35.	0.0	0.0		0.0	0.0	0.0
EM-240-F	FTP 3-Bag	26.	67.	63.	120.				
	FTPC	27.	74.	74.	66.				
	FTPH	27.	61.	54.	170.				
	CFDS	8.7	69.	64.	140.				
	FET	21.	30.	0.0	115.				
	NYCC	0.0	150.	71.	75.				
	Idle	46.	230.	39.	390.	0.0	1.8	0.0	0.0
	50 KPH	47.	160.	9.9	16.	0.27	0.84	0.0	
	85 KPH	9.2	14.	0.0	67.	1.7	2.0	0.0	0.0
EM-241-F	FTP 3-Bag	43.	120.	73.	150.				
	FTPC	41.	120.	61.	230.				
	FTPH	47.	120.	88.	80.				
	CFDS	15.	37.	12.	49.				
	FET	0.0	48.	10.	130.				
	NYCC	24.	160.	93.	220.				
	Idle	120.	290.	45.	360.	0.0	15.	0.35	15.0
	50 KPH	41.	120.	35.	120.	3.1	8.5	0.12	5.0
	85 KPH	31.	31.	6.2	36.	2.2	5.4	0.0	2.0
EM-242-F	FTP 3-Bag	37.	43.	20.	0.0				
	FTPC	38.	54.	13.	0.0				
	FTPH	35.	35.	27.	0.0				
	CFDS	2.4	0.24	0.0	0.0				
	FET	97.	43.	33.	0.0				
	NYCC	620.	190.	180.	0.0				
	Idle	790.	320.	160.	0.0	0.0	1.5	0.0	0.0
	50 KPH	30.	48.	30.	23.	0.0	0.37	0.0	0.0
	85 KPH	48.	48.	0.0	0.0	1.0	1.3	0.0	0.0

[a] plus salicylaldehyde
[b] plus 2,5-xylenol
[c] plus 3,5-xylenol

APPENDIX G

SMOKE AND PARTICULATE EMISSIONS DATA

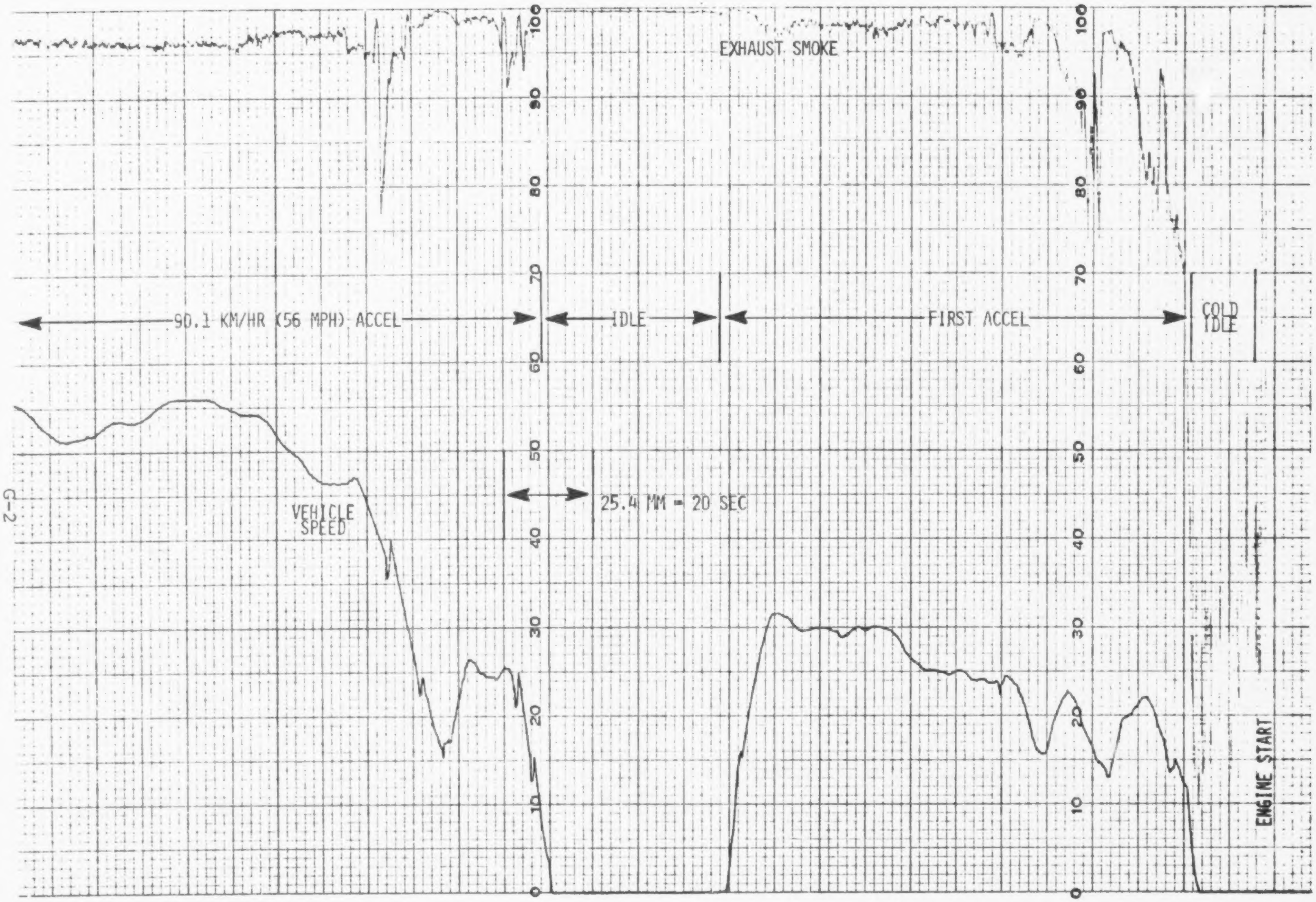

FIGURE G-1. VOLKSWAGEN RABBIT DIESEL COLD START SMOKE TRACE, EM-241-F "MINIMUM QUALITY" NO. 2 FUEL

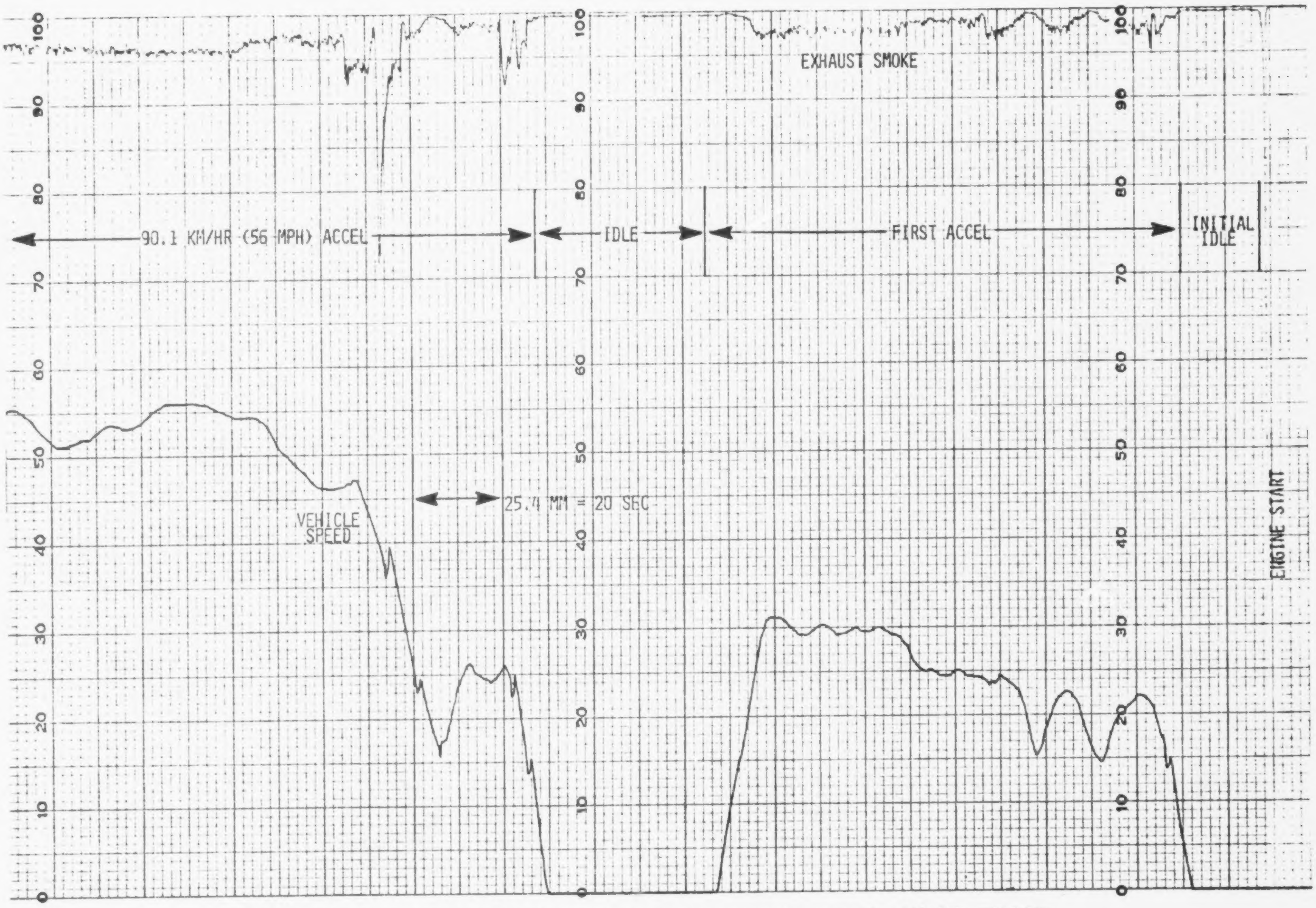

FIGURE G-2. VOLKSWAGEN RABBIT DIESEL HOT START SMOKE TRACE, EM-241-F "MINIMUM QUALITY" NO. 2 FUEL

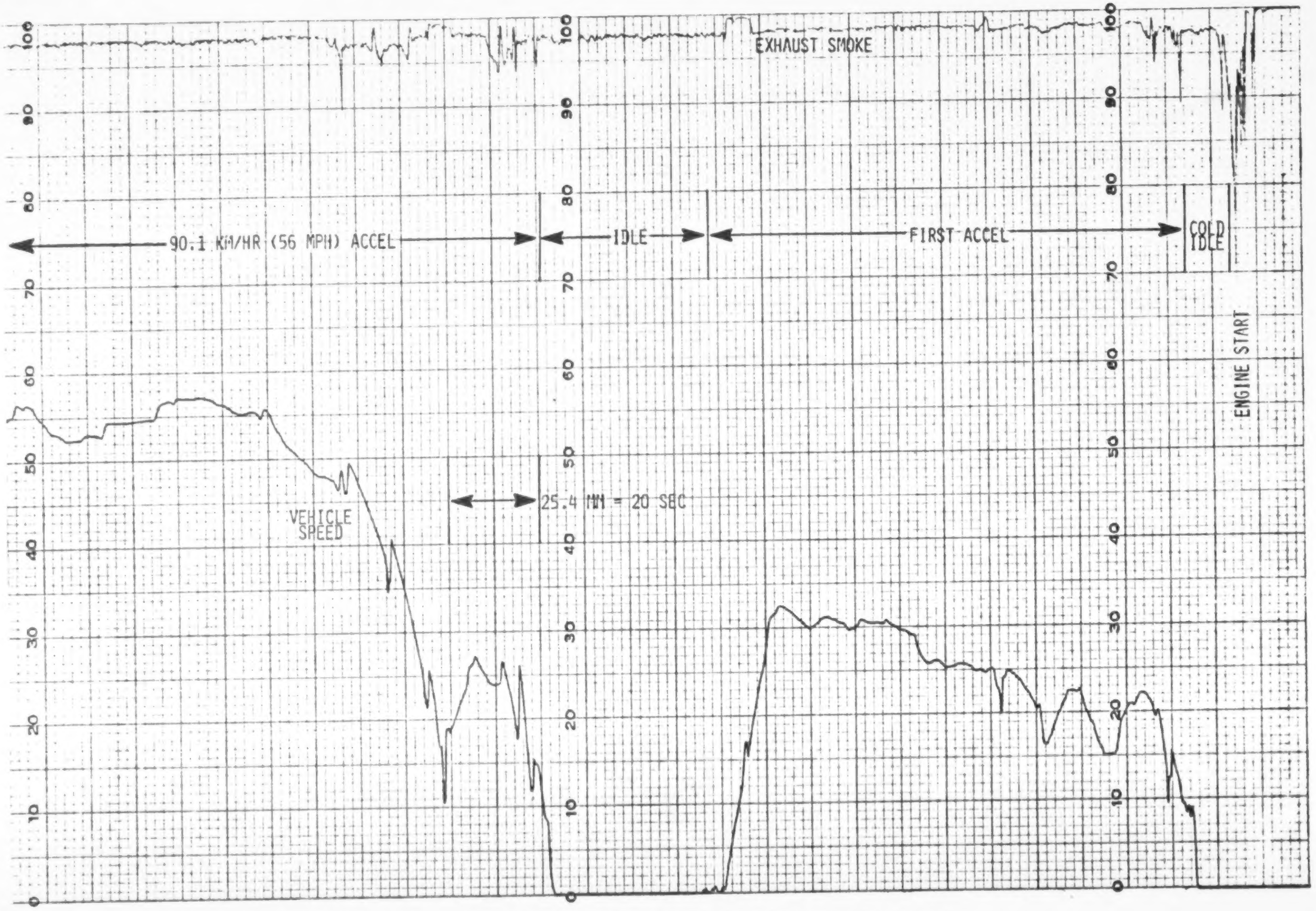

FIGURE G-3. MERCEDES 240D COLD START SMOKE TRACE, EM-241-F "MINIMUM QUALITY" NO. 2 FUEL

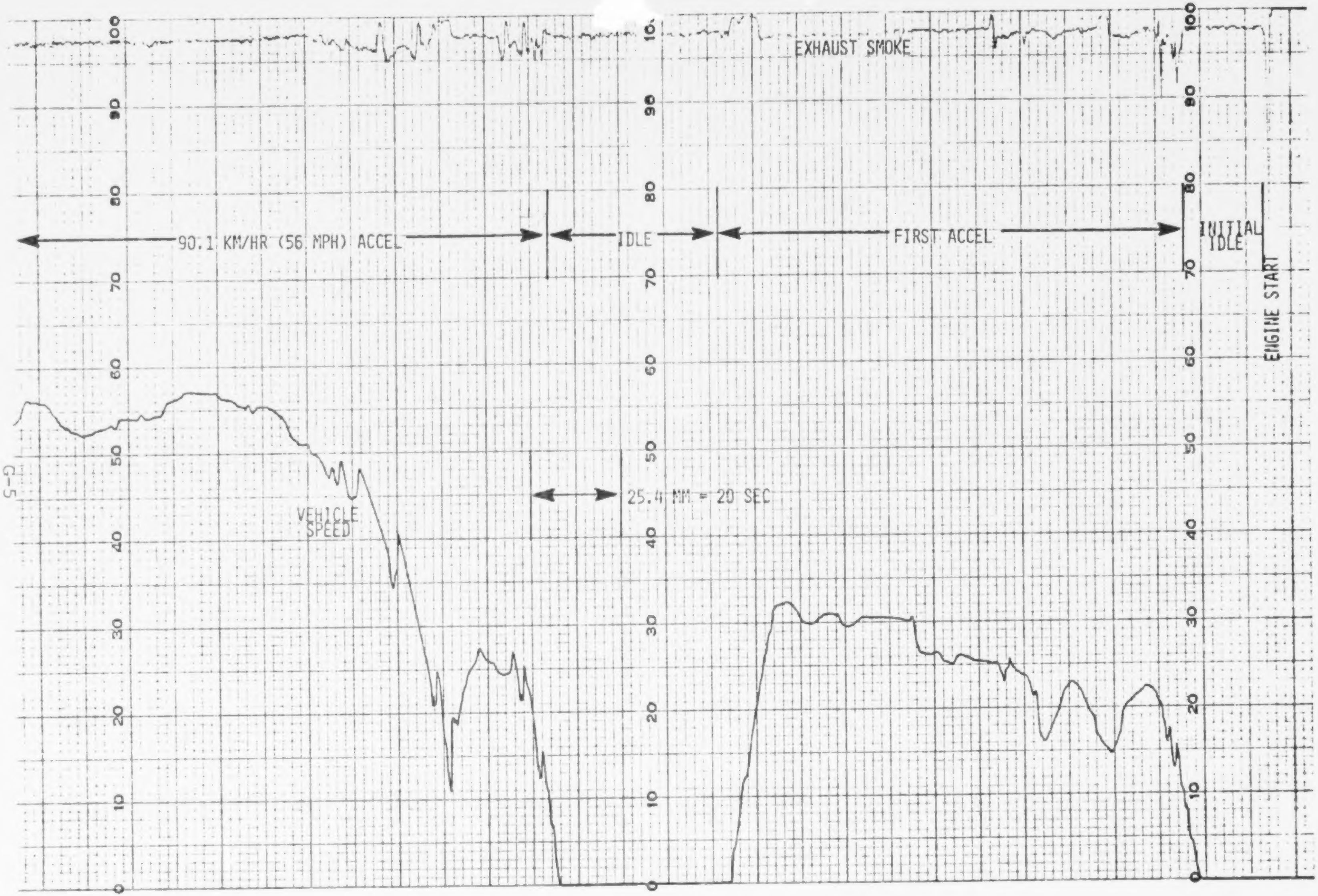

FIGURE G-4. MERCEDES 240D HOT START SMOKE TRACE, EM-241-F "MINIMUM QUALITY" NO. 2 FUEL

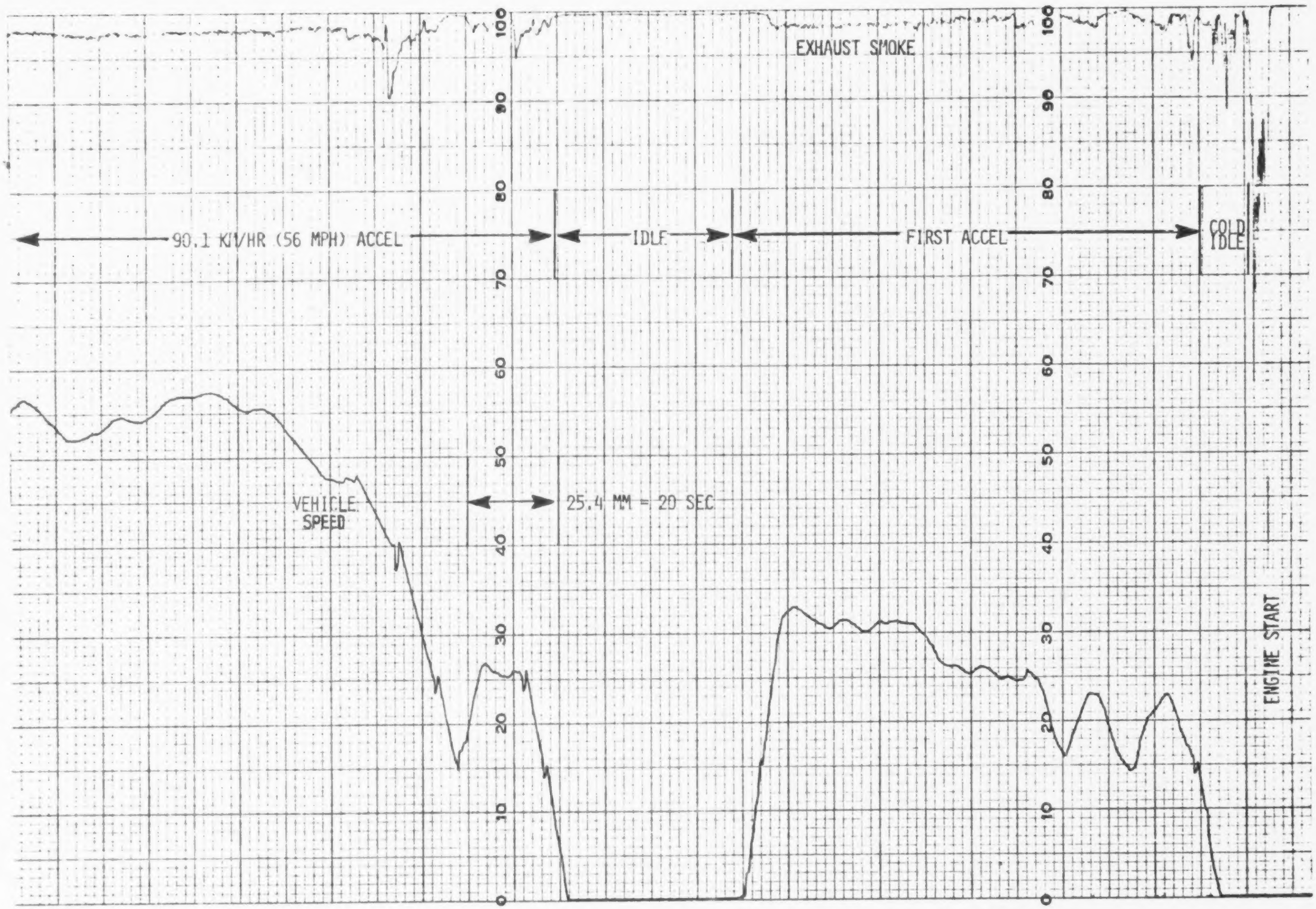

FIGURE G-5. VOLKSWAGEN RABBIT DIESEL COLD START SMOKE TRACE, EM-240-D "JET A" NO. 1 FUEL

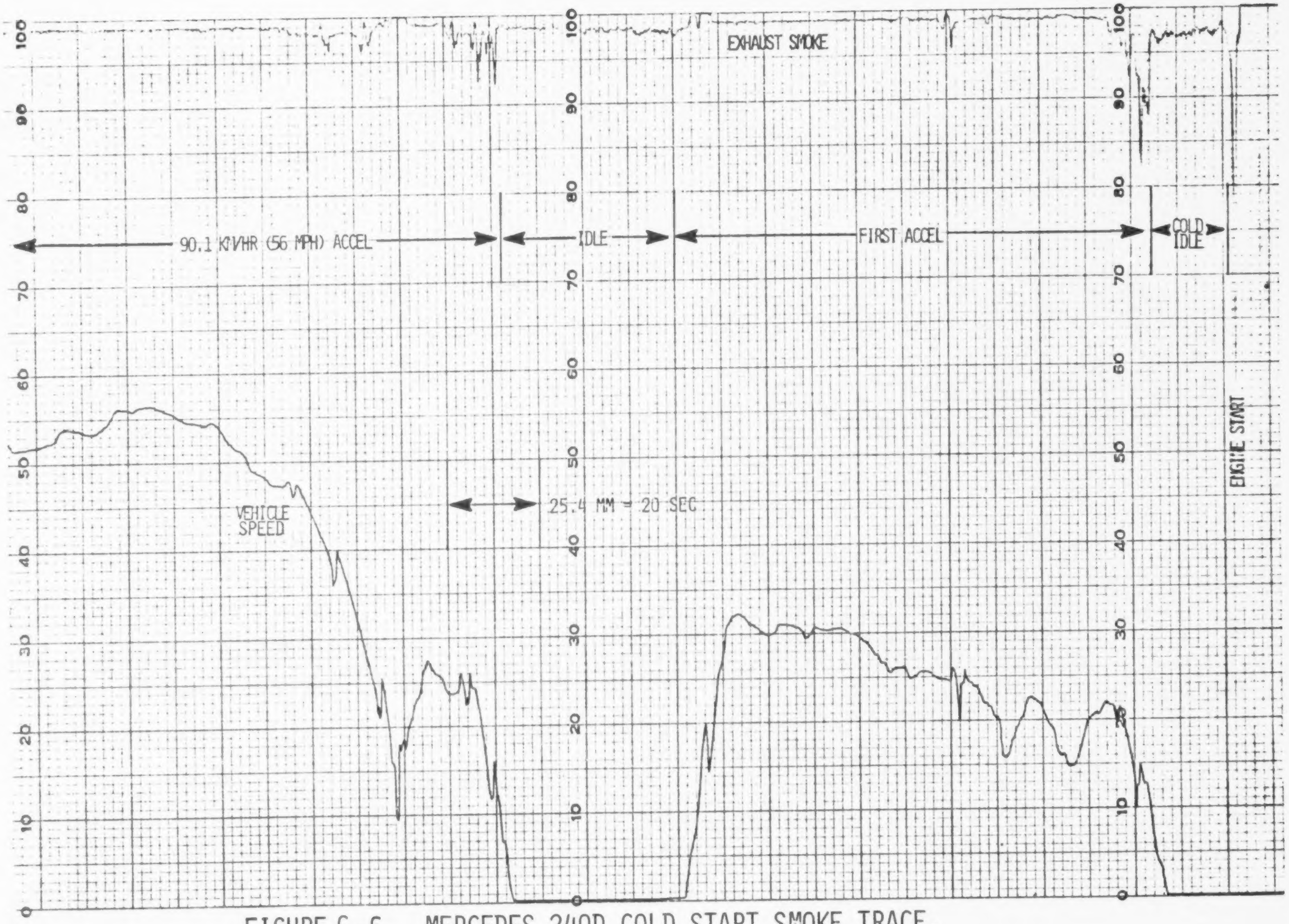

FIGURE G-6. MERCEDES 240D COLD START SMOKE TRACE, EM-240-D "JET A" NO. 1 FUEL

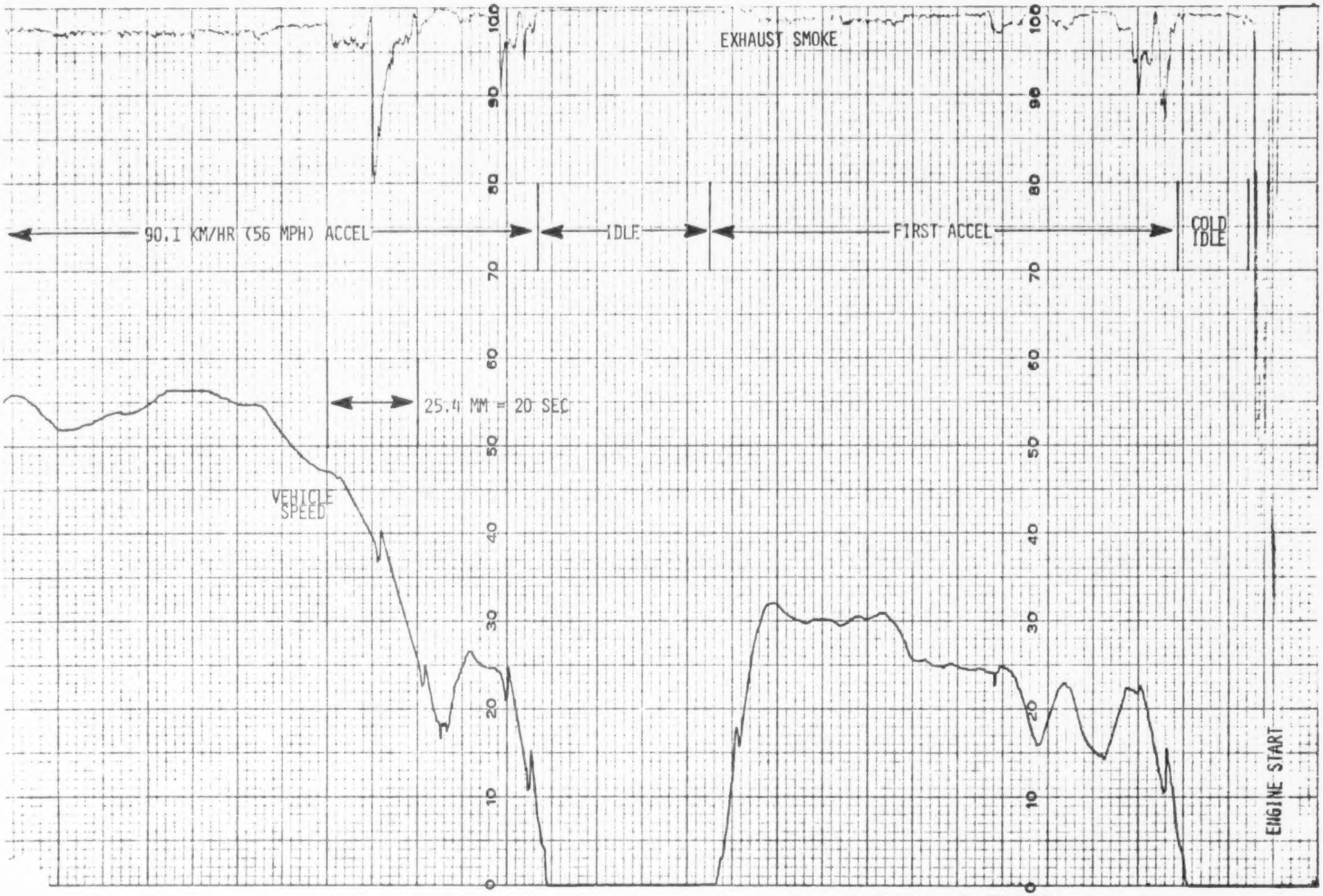

FIGURE G-7. VOLKSWAGEN RABBIT DIESEL COLD START SMOKE TRACE, EM-242-F "PREMIUM" NO. 2 FUEL

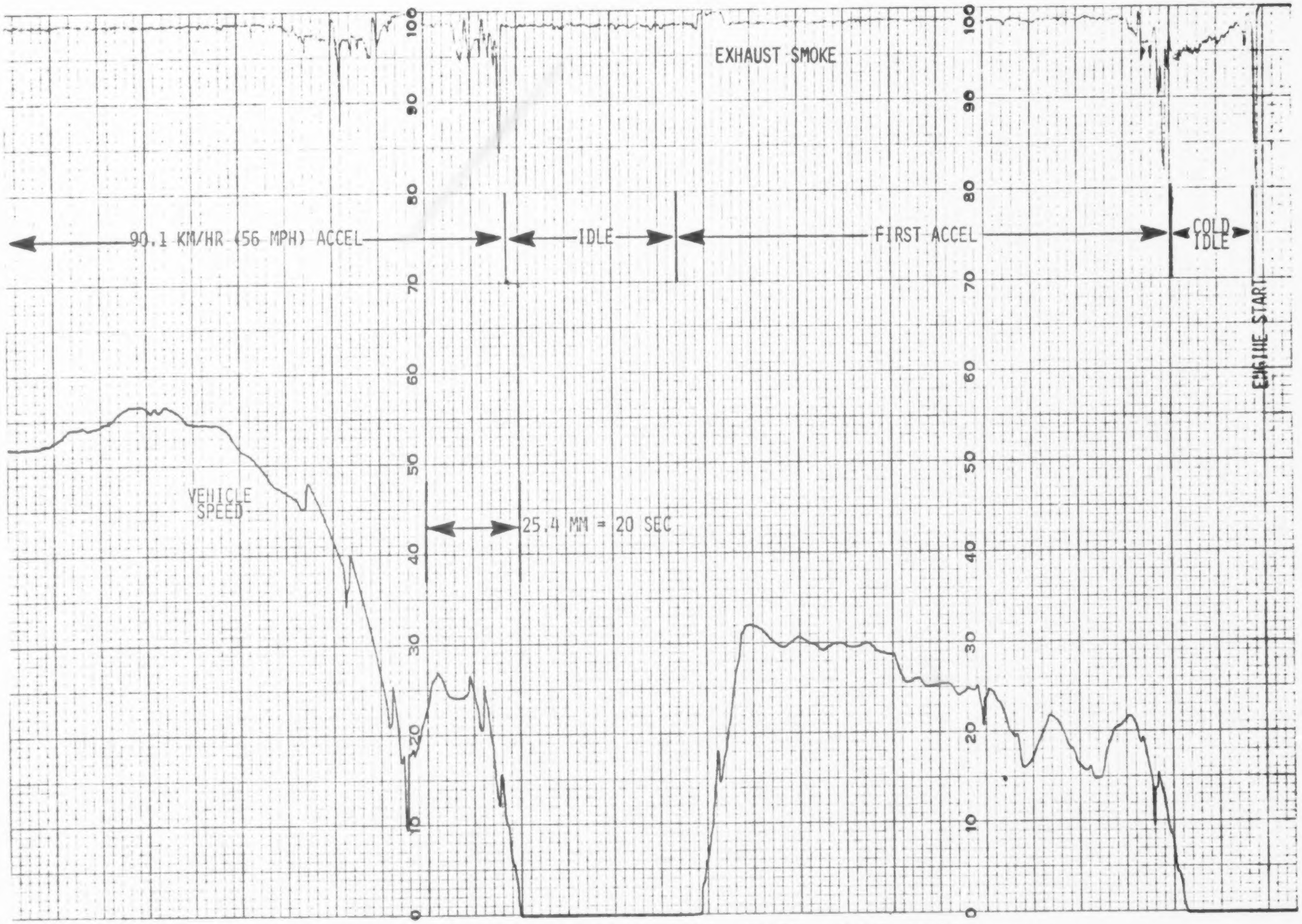

FIGURE G-8. MERCEDES 240D COLD START SMOKE TRACE, EM-239-F "NATIONAL AVERAGE" NO. 2 FUEL

MERCEDES 240D PARTICULATE - DISTANCE BASIS

	VAR. 4 TOT PART G/KM	VAR. 5 PART CON MG/M3	VAR. 6 TOT SOL. PCT	VAR. 7 CARBON MG/KM	VAR. 8 HYDROGEN MG/KM	VAR. 9 NITROGEN MG/KM	VAR. 10 SULFUR MG/KM	VAR. 11 SULFATE MG/KM	VAR. 12 BAP μG/KM	VAR. 13 CR PCT	VAR. 14 PB PCT	VAR. 15 MN PCT	VAR. 16 BR PCT	VAR. 17 P PCT
FUEL 238														
FTP 3BAG	.3290	103.4000	11.2000	246.0000	9.3500	1.1300	3.5000	8.1900	.3860	.0800	.6500	.3300	0.0000	.0118
FTP C	.3350	104.0000	10.7000	258.0000	9.7200	1.3400	3.4000	8.7000	.3800	0.0000	.5300	.2400	0.0000	.0160
FTP H	.3240	103.0000	11.5000	237.0000	9.0700	.9720	3.2000	7.8000	.3900	.1400	.7400	.3900	0.0000	.0086
CFDS	.2610	115.0000	7.7000	189.0000	6.7900	1.0400	4.1000	10.0000	.1300	.0650	.2400	.1200	0.0000	.0088
FET	.2120	113.0000	6.4000	155.0000	4.8800	.6360	3.0000	13.0000	.0760	0.0000	.4800	.2200	0.0000	.0065
NYCC	.6800	140.0000	11.4000	518.0000	17.7000	3.4000	3.6000	13.0000	1.9000	0.0000	1.7000	.9700	0.0000	0.0000
IDLE[a]	2.9900	90.6000	9.3000	1880.0000	74.8000	12.0000	31.0000	78.0000	12.0000	0.0000	3.1000	1.3000	0.0000	0.0000
50 KPH	.1500	81.9000	10.2000	117.0000	4.0500	.3000	1.2000	3.4000	.1400	0.0000	.4700	0.0000	0.0000	0.0000
85 KPH	.1960	103.0000	7.7000	145.0000	5.8800	.7840	3.7000	9.6000	.0790	0.0000	.4900	.2200	0.0000	.0110
FUEL 239														
FTP 3BAG	.3140	98.9000	9.8000	232.3000	11.8400	2.9680	2.7400	7.5000	.4600	.0600	.4400	.2100	0.0000	.0118
FTP C	.3190	99.5000	9.7000	234.0000	11.5000	3.1900	2.9000	8.3000	.5400	.1400	.3900	.1900	0.0000	.0160
FTP H	.3110	98.5000	9.8000	231.0000	12.1000	2.8000	2.7000	6.9000	.4000	0.0000	.4800	.2200	0.0000	.0087
CFDS	.2260	99.7000	7.9000	166.0000	7.2300	6.3300	2.6000	9.6000	.1900	0.0000	.3400	.2000	0.0000	.0068
FET	.1920	102.0000	7.6000	141.0000	5.5700	6.1400	1.9000	8.3000	.0670	0.0000	.9500	.5100	0.0000	.0061
NYCC	.5650	116.0000	7.9000	477.0000	27.1000	6.7800	2.6000	6.8000	2.7000	0.0000	1.6000	.9200	0.0000	0.0000
IDLE[a]	3.1600	95.8000	6.0000	2570.0000	142.0000	69.5000	15.0000	43.0000	19.0000	0.0000	2.0000	1.1000	0.0000	0.0000
50 KPH	.1420	77.5000	9.0000	124.0000	4.5400	2.7000	.7600	2.0000	.1200	0.0000	.7400	.4100	0.0000	0.0000
85 KPH	.1650	87.0000	8.6000	125.0000	4.7800	1.3200	2.4000	7.8000	.0330	0.0000	.5600	.2900	0.0000	.0150
FUEL 240														
FTP 3BAG	.2350	73.9000	12.0000	180.1000	6.3300	1.1940	.7700	2.1200	.3230	0.0000	.6400	.2900	.0600	.1622
FTP C	.2510	78.3000	12.2000	200.0000	7.0300	1.0000	.8800	2.8000	.3800	0.0000	.7800	.2600	.1500	.0340
FTP H	.2230	70.6000	11.9000	165.0000	5.8000	1.3400	.6900	1.6000	.2800	0.0000	.5300	.2900	0.0000	.0280
CFDS	.1660	73.2000	10.4000	123.0000	3.8200	1.4900	.8300	2.4000	.1700	0.0000	.4600	.2200	0.0000	.0390
FET	.1400	74.4000	11.7000	126.0000	4.2000	2.9400	.7800	2.4000	.1600	0.0000	.7900	.3800	0.0000	.0230
NYCC	.3170	65.3000	25.7000	254.0000	8.5600	7.9200	.6000	1.5000	.7500	0.0000	0.0000	0.0000	0.0000	0.0000
IDLE[a]	1.5000	45.4000	20.1000	1170.0000	63.0000	6.0000	4.7000	7.0000	9.2000	0.0000	2.2000	1.3000	0.0000	0.0000
50 KPH	.1140	62.2000	12.7000	101.0000	1.2500	.9120	.1900	.5100	.0480	0.0000	1.2000	.6300	0.0000	.0150
85 KPH	.1360	71.7000	9.8000	103.0000	3.4000	1.0900	.4000	1.5000	.1400	0.0000	.3700	.1800	0.0000	.0280
FUEL 241														
FTP 3BAG	.3800	119.0000	7.6000	288.8000	12.0300	1.5160	3.8300	9.4300	.6200	.0520	.3000	.1800	0.0000	.0213
FTP C	.4080	127.0000	8.3000	307.0000	11.8000	1.6300	4.0000	9.6000	.7400	.1200	.3300	.1900	0.0000	.0270
FTP H	.3580	113.0000	7.0000	275.0000	12.2000	1.4300	3.7000	9.3000	.5300	0.0000	.2700	.1800	0.0000	.0170
CFDS	.2570	113.0000	5.5000	192.0000	7.2000	1.2900	4.4000	12.0000	.1600	0.0000	.2200	.1400	0.0000	.0220
FET	.2580	137.0000	4.7000	187.0000	5.7500	.8770	3.1000	12.0000	.0860	0.0000	.4100	.2800	0.0000	.0240
NYCC	.8080	166.0000	3.1000	617.0000	16.2000	3.2300	5.5000	7.4000	4.0000	0.0000	.6600	.4600	0.0000	.0140
IDLE[a]	4.0000	121.0000	4.1000	2670.0000	108.0000	24.0000	31.0000	62.0000	55.0000	0.0000	0.0000	.5200	0.0000	0.0000
50 KPH	.1500	81.9000	4.7000	129.0000	7.6500	.7500	1.4000	2.8000	.1500	0.0000	0.0000	0.0000	0.0000	.0081
85 KPH	.2310	122.0000	6.0000	174.0000	7.8500	.9240	3.3000	8.1000	.0350	0.0000	.2400	.1400	0.0000	.0190
FUEL 242														
FTP 3BAG	.2920	91.7000	8.9000	216.0000	7.7100	1.1660	3.7000	8.7100	.2300	.4180	0.0000	0.0000	0.0000	.0209
FTP C	.2990	93.3000	9.5000	228.0000	8.0700	1.2000	4.1000	7.4000	.2300	.3500	0.0000	0.0000	0.0000	.0260
FTP H	.2860	90.6000	8.5000	207.0000	7.4400	1.1400	3.4000	9.7000	.2300	.4700	0.0000	0.0000	0.0000	.0170
CFDS	.2030	89.5000	7.0000	146.0000	5.0800	.8120	4.9000	11.0000	.1300	.4300	0.0000	0.0000	0.0000	.0250
FET	.1810	96.2000	2.3000	128.0000	5.0700	.9050	3.4000	7.4000	.1500	0.0000	0.0000	0.0000	0.0000	.0120
NYCC	.5630	116.0000	3.9000	424.0000	14.6000	3.9400	4.4000	8.5000	.7500	0.0000	0.0000	0.0000	0.0000	0.0000
IDLE[a]	2.7100	82.1000	6.5000	1720.0000	67.6000	19.0000	28.0000	57.0000	4.1000	0.0000	0.0000	0.0000	0.0000	0.0000
50 KPH	.1310	71.5000	7.3000	78.6000	4.3200	.4170	1.2000	2.5000	.3800	0.0000	0.0000	0.0000	0.0000	.0970
85 KPH	.1950	103.0000	4.9000	150.0000	5.0700	.7800	4.1000	8.4000	.0280	0.0000	0.0000	0.0000	0.0000	.0160

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[a] idle emissions per hour (/h) rather than per kilometer (/km)

MERCEDES 240D PARTICULATE - DISTANCE BASIS

	VAR. 18 SI PCT	VAR. 19 CD PCT	VAR. 20 AL PCT	VAR. 21 NA PCT	VAR. 22 MG PCT	VAR. 23 K PCT	VAR. 24 CL PCT	VAR. 25 ZN PCT	VAR. 26 CU PCT	VAR. 27 NI PCT	VAR. 28 FE PCT	VAR. 24 BA PCT	VAR. 30 CA PCT	VAR. 31[a] O-CRESOL MG/KM
FUEL 238														
FTP 3BAG	.0023	.0049	0.0000	0.0000	0.0000	0.0000	.0042	.0710	.0560	0.0000	.2530	.0014	.0730	
FTP C	.0025	.0052	0.0000	0.0000	0.0000	0.0000	.0097	.0890	0.0000	0.0000	.4300	0.0000	.0860	
FTP H	.0021	.0047	0.0000	0.0000	0.0000	0.0000	0.0000	.0570	.0990	0.0000	.1200	.0025	.0630	
CFDS	0.0000	.0025	0.0000	0.0000	0.0000	0.0000	0.0000	.0360	0.0000	0.0000	.0500	0.0000	.0250	
FET	0.0000	.0065	0.0000	0.0000	0.0000	0.0000	0.0000	.0430	0.0000	0.0000	.0780	.0190	.0390	
NYCC	0.0000	.0200	0.0000	0.0000	0.0000	0.0000	0.0000	.0790	0.0000	0.0000	0.0000	0.0000	.0390	
IDLE[b]	0.0000	.0100	0.0000	0.0000	0.0000	0.0000	0.0000	.1300	.3500	0.0000	0.0000	0.0000	.0500	0.0000
50 KPH	0.0000	.0038	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	.0370	.0240
85 KPH	0.0000	.0039	0.0000	0.0000	0.0000	0.0000	0.0000	.0490	0.0000	0.0000	0.0000	0.0000	.0410	.0070
FUEL 239														
FTP 3BAG	.0018	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.0460	0.0000	0.0000	.1330	0.0000	.0650	
FTP C	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.0740	0.0000	0.0000	.3100	0.0000	.0630	
FTP H	.0032	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.0240	0.0000	0.0000	0.0000	0.0000	.0670	
CFDS	0.0000	.0006	0.0000	0.0000	0.0000	0.0000	0.0000	.0480	0.0000	0.0000	.0670	0.0000	.0300	
FET	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.0490	0.0000	0.0000	0.0000	0.0000	.0300	
NYCC	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
IDLE[b]	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000
50 KPH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.0470	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
85 KPH	0.0000	0.0000	.0034	.0310	0.0000	0.0000	0.0000	.0450	0.0000	0.0000	0.0000	0.0000	.0310	.0110
FUEL 240														
FTP 3BAG	.0070	.0010	.0011	.4030	0.0000	.0062	.0146	.1070	0.0000	.0090	.2430	.0065	.1220	
FTP C	.0110	.0024	0.0000	.4600	0.0000	.0100	.0340	.1200	0.0000	.0220	.3000	.0150	.1500	
FTP H	.0039	0.0000	.0020	.3600	0.0000	.0034	0.0000	.0970	0.0000	0.0000	.2000	0.0000	.1000	
CFDS	.0060	.0016	0.0000	.6200	0.0000	.0056	.0150	.0980	0.0000	.0270	.1600	.0180	.1400	
FET	.0036	.0036	0.0000	0.0000	0.0000	.0036	0.0000	.0680	0.0000	0.0000	1.0000	.0310	.1200	
NYCC	0.0000	0.0000	0.0000	0.0000	0.0000	.0260	0.0000	.1900	0.0000	0.0000	0.0000	0.0000	.1100	
IDLE[b]	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.0880	.1800	0.0000
50 KPH	.0070	0.0000	0.0000	0.0000	0.0000	.0150	0.0000	.1000	0.0000	.0440	0.0000	0.0000	.1000	0.0000
85 KPH	0.0000	0.0000	0.0000	0.0000	0.0000	.0034	0.0000	.0760	0.0000	0.0000	0.0000	0.0000	.0990	.0210
FUEL 241														
FTP 3BAG	.0037	0.0000	.00 1	0.0000	0.0000	.0011	0.0000	.1030	0.0000	0.0000	.2680	.0087	.0620	
FTP C	.0086	0.0000	.0048	0.0000	0.0000	.0025	0.0000	.1300	0.0000	0.0000	.4500	.0070	.0820	
FTP H	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.0820	0.0000	0.0000	.1300	.0100	.0440	
CFDS	0.0000	0.0000	0.0000	0.0000	0.0000	.0020	0.0000	.0960	0.0000	0.0000	.1000	.0093	.0410	
FET	0.0000	0.0000	.0050	0.0000	0.0000	0.0000	0.0000	.1000	0.0000	0.0000	.0950	0.0000	.0410	
NYCC	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.1100	0.0000	0.0000	0.0000	0.0000	.0480	
IDLE[b]	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.0390	0.0000
50 KPH	0.0000	0.0000	0.0000	0.0000	0.0000	.0032	0.0000	.0700	0.0000	0.0000	0.0000	0.0000	.0160	0.0000
85 KPH	0.0000	0.0000	0.0000	0.0000	0.0000	.0013	0.0000	.0740	0.0000	0.0000	.0330	0.0000	.0330	0.0000
FUEL 242														
FTP 3BAG	.0062	.0022	.0065	0.0000	0.0000	.0065	0.0000	.0670	0.0000	0.0000	.2980	0.0000	.0640	
FTP C	.0110	.0030	.0052	0.0000	0.0000	.0085	0.0000	.0970	0.0000	0.0000	.5200	0.0000	.1000	
FTP H	.0025	.0016	.0074	0.0000	0.0000	.0050	0.0000	.0440	0.0000	0.0000	.1300	0.0000	.0450	
CFDS	.0020	.0026	.0034	0.0000	0.0000	.0043	0.0000	.0740	0.0000	0.0000	.2000	0.0000	.0710	
FET	0.0000	0.0000	0.0000	0.0000	0.0000	.0063	0.0000	.0310	0.0000	0.0000	0.0000	0.0000	.0310	
NYCC	0.0000	0.0000	0.0000	0.0000	0.0000	.0029	0.0000	0.0000	0.0000	.0580	0.0000	0.0000	.0380	
IDLE[b]	0.0000	0.0000	0.0000	0.0000	0.0000	.0250	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
50 KPH	0.0000	0.0000	0.0000	0.0000	0.0000	.0039	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
85 KPH	0.0000	.0009	0.0000	0.0000	0.0000	.0034	0.0000	.0360	0.0000	0.0000	0.0000	0.0000	.0340	.0010

[a] plus salicylaldehyde

[b] idle emissions per hour (/h) rather than per kilometer (/km)

MERCEDES 240D PARTICULATE - DISTANCE BASIS

	VAR. 32 P-CRESOL MG/KM	VAR. 33[a] 2,4-XYL MG/KM	VAR. 34[b] 2,3-XYL MG/KM	VAR. 35 100-CHNS PCT	VAR. 36 SUM VAR PCT
FUEL 238					
FTP 3BAG				20.9500	1.5350
FTP C				18.5000	1.4100
FTP H				22.8000	1.6300
CFDS				23.0000	.5470
FET				24.3000	.8920
NYCC				20.2000	2.8100
IDLE[c]	0.0000	0.0000	0.0000	33.2000	4.9400
50 KPH	.0150	0.0000	0.0000	18.3000	.5110
85 KPH	.0060	0.0000	0.0000	20.7000	.8150
FUEL 239					
FTP 3BAG				20.5300	.9650
FTP C				21.1000	1.1800
FTP H				20.1000	.8030
CFDS				19.4000	.6940
FET				19.5000	1.5500
NYCC				9.1200	2.5200
IDLE[c]	0.0000	0.0000	0.0000	11.5000	3.1000
50 KPH	0.0000	0.0000	0.0000	7.0400	1.2000
85 KPH	.0120	0.0000	0.0000	19.1000	.9750
FUEL 240					
FTP 3BAG				20.0500	1.9370
FTP C				16.8000	2.3700
FTP H				22.5000	1.6100
CFDS				22.2000	1.8100
FET				4.3400	2.4200
NYCC				14.5000	.3260
IDLE[c]	0.0000	0.0000	0.0000	17.1000	3.7700
50 KPH	0.0000	0.0000	0.0000	9.3400	2.1100
85 KPH	.0070	0.0000	0.0000	20.7000	.7560
FUEL 241					
FTP 3BAG				19.2500	1.0030
FTP C				20.5000	1.3600
FTP H				18.3000	.7330
CFDS				20.3000	.6300
FET				23.8000	.9550
NYCC				20.6000	1.3100
IDLE[c]	0.0000	0.0000	0.0000	29.2000	.5590
50 KPH	0.0000	0.0000	0.0000	7.5000	.0920
85 KPH	0.0000	0.0000	0.0000	19.5000	.5400
FUEL 242					
FTP 3BAG				21.6400	.8940
FTP C				19.3000	1.1200
FTP H				23.4000	.7230
CFDS				22.8000	.8120
FET				24.1000	.0800
NYCC				20.6000	.1040
IDLE[c]	0.0000	0.0000	0.0000	32.3000	.0250
50 KPH	0.0000	0.0000	0.0000	35.1000	.1010
85 KPH	.0040	0.0000	0.0000	18.0000	.0900

[a] plus 2,5-xylenol
[b] plus 3,5-xylenol
[c] idle emissions per hour (/h) rather than per kilometer (/km)

VW RABBIT DIESEL PARTICULATE - DISTANCE BASIS

	VAR. 4 TOT PART G/KM	VAR. 5 PART CON MG/M3	VAR. 6 TOT SOL. PCT	VAR. 7 CARBON MG/KM	VAR. 8 HYDROGEN MG/KM	VAR. 9 NITROGEN MG/KM	VAR. 10 SULFUR MG/KM	VAR. 11 SULFATE MG/KM	VAR. 12 BAP μG/KM	VAR. 13 CR PCT	VAR. 14 PB PCT	VAR. 15 MN PCT	VAR. 16 BR PCT	VAR. 17 P PCT
FUEL 238														
FTP 3BAG	.2250	80.2000	10.8000	157.6000	8.8800	.8990	2.0900	6.3000	1.1310	0.0000	.5300	.2700	0.0000	.0229
FTP C	.2520	86.9000	12.2000	173.0000	9.5800	1.0100	2.2000	7.4000	1.9000	0.0000	.7400	.3700	0.0000	.0240
FTP H	.2040	75.1000	9.8000	146.0000	8.3600	.8160	2.0000	5.1000	.5500	0.0000	.3700	.2000	0.0000	.0220
CFDS	.2060	105.0000	14.6000	154.0000	9.0600	1.2400	3.2000	9.2000	.3600	.1500	.1900	0.0000	0.0000	.0270
FET	.1730	105.0000	9.1000	121.0000	6.2300	.6920	2.2000	7.0000	.3900	0.0000	0.0000	0.0000	0.0000	.0220
NYCC	.3630	86.6000	14.4000	170.0000	11.3000	.7260	2.0000	6.0000	1.7000	0.0000	3.2000	1.5000	0.0000	0.0000
IDLE [a]	1.9300	49.5000	10.0000	629.0000	77.2000	23.2000	18.0000	44.0000	4.5000	0.0000	5.7000	2.8000	0.0000	0.0000
50 KPH	.0900	56.9000	14.9000	54.4000	5.2200	.7200	.3600	1.4000	.3400	0.0000	2.4000	1.1000	0.0000	0.0000
85 KPH	.1670	102.0000	14.0000	126.0000	6.5100	.8350	2.4000	6.5000	.2500	0.0000	.3900	.1900	0.0000	.0210
FUEL 239														
FTP 3BAG	.2180	77.8000	13.2000	151.0000	9.1700	2.0740	1.5600	5.1700	1.3310	0.0000	.8000	.4300	0.0000	.0306
FTP C	.2500	86.2000	11.6000	167.0000	9.5000	2.0000	1.9000	6.2000	2.3000	0.0000	.8400	.4500	0.0000	.0340
FTP H	.1940	71.4000	14.4000	139.0000	8.9200	2.1300	1.3000	4.4000	.6000	0.0000	.7700	.4200	0.0000	.0280
CFDS	.1940	98.8000	13.2000	140.0000	5.2400	2.1300	2.0000	7.1000	.3900	0.0000	.5700	.2800	0.0000	.0280
FET	.1430	86.6000	14.3000	108.0000	6.5800	1.2900	1.2000	4.4000	.2500	0.0000	.8400	.4700	0.0000	.0290
NYCC	.3840	91.6000	27.5000	228.0000	29.2000	6.5300	1.3000	4.3000	1.6000	0.0000	3.1000	1.9000	0.0000	0.0000
IDLE [a]	2.1200	54.4000	18.4000	748.0000	174.0000	38.2000	14.0000	70.0000	5.3000	0.0000	0.0000	0.0000	0.0000	0.0000
50 KPH	.0680	43.0000	22.7000	41.6000	5.5100	.8840	.2400	.9000	.3300	0.0000	1.9000	1.1000	0.0000	0.0000
85 KPH	.1480	90.1000	12.7000	123.0000	6.6600	1.3300	1.5000	5.0000	.2200	0.0000	.5900	.3100	0.0000	.0160
FUEL 240														
FTP 3BAG	.1770	62.9000	15.0000	121.9000	5.9100	.4430	.6800	2.3500	1.1790	0.0000	.8400	.4300	0.0000	.0393
FTP C	.2090	72.1000	13.2000	139.0000	6.6900	.4600	1.0000	3.6000	2.0000	0.0000	.4900	.2500	0.0000	.0330
FTP H	.1520	55.9000	16.4000	109.0000	5.3200	.4300	.4400	1.4000	.5600	0.0000	1.1000	.5600	0.0000	.0440
CFDS	.1490	75.9000	15.2000	101.0000	6.1100	.4200	.4500	2.3000	1.2000	0.0000	.5600	.3000	0.0000	.0500
FET	.1380	83.6000	15.3000	92.2000	5.8000	.3200	.3600	1.0000	.8700	0.0000	.5500	.3100	0.0000	.0150
NYCC	.2950	70.4000	18.7000	159.0000	10.6000	1.1000	.2800	4.2000	.3500	0.0000	4.0000	2.5000	0.0000	0.0000
IDLE [a]	.7420	19.0000	19.6000	303.0000	21.5000	4.0000	1.5000	12.0000	0.0000	0.0000	15.0000	8.1000	0.0000	0.0000
50 KPH	.0470	29.7000	15.7000	28.6000	2.3000	.1800	.0300	.3200	.0190	0.0000	2.4000	1.5000	0.0000	0.0000
85 KPH	.1030	62.7000	13.4000	80.3000	3.7100	.2600	.2400	1.4000	.7400	0.0000	.6400	.3300	0.0000	.0240
FUEL 241														
FTP 3BAG	.3750	132.3000	15.6000	257.8000	18.6700	1.6330	1.4400	8.0100	3.6370	0.0000	.1800	.1300	0.0000	.0227
FTP C	.5650	195.0000	11.8000	398.0000	29.9000	2.2600	2.4000	11.0000	7.0000	0.0000	0.0000	0.0000	0.0000	.0170
FTP H	.2310	85.0000	18.4000	152.0000	10.2000	1.1600	1.6000	5.1000	1.1000	0.0000	.3200	.2200	0.0000	.0270
CFDS	.2220	113.0000	15.4000	155.0000	8.6600	1.1100	2.3000	8.0000	.7300	0.0000	.3000	.2000	0.0000	.0250
FET	.1740	105.0000	15.4000	125.0000	6.2600	.6960	1.5000	5.0000	.4100	0.0000	.4600	.3200	0.0000	.0220
NYCC	.4500	107.0000	18.0000	147.0000	10.8000	4.0500	1.4000	7.6000	1.5000	0.0000	1.8000	1.1000	0.0000	0.0000
IDLE [a]	2.8400	72.8000	16.3000	1070.0000	125.0000	19.9000	17.0000	110.0000	4.8000	0.0000	0.0000	0.0000	0.0000	0.0000
50 KPH	.1970	125.0000	15.4000	111.0000	15.2000	.5910	.3600	1.1000	.0960	0.0000	1.4000	1.0000	0.0000	.0140
85 KPH	.1890	115.0000	21.6000	142.0000	6.4300	1.1300	1.3000	4.9000	.3200	0.0000	.3300	.2300	0.0000	.0170
FUEL 242														
FTP 3BAG	.1940	69.2000	13.6000	138.2000	7.6800	1.1680	2.1700	4.0000	1.0480	.3740	0.0000	0.0000	0.0000	.0433
FTP C	.2210	76.2000	13.5000	153.0000	8.4000	1.1000	2.4000	5.2000	1.8000	.8700	0.0000	0.0000	0.0000	.0450
FTP H	.1740	64.0000	13.7000	127.0000	7.1300	1.2200	2.0000	3.1000	.4800	0.0000	0.0000	0.0000	0.0000	.0420
CFDS	.1560	79.4000	14.3000	108.0000	6.4000	.7800	2.8000	6.7000	.3000	0.0000	0.0000	0.0000	0.0000	.0320
FET	.1750	106.0000	12.9000	124.0000	7.1800	.8750	1.3000	7.5000	.4000	0.0000	0.0000	0.0000	0.0000	.0130
NYCC	.4020	95.9000	11.6000	209.0000	18.5000	3.2200	1.3000	4.9000	1.4000	0.0000	0.0000	0.0000	0.0000	.0310
IDLE [a]	2.1000	53.8000	11.4000	561.0000	107.0000	29.4000	14.0000	54.0000	3.5000	0.0000	0.0000	0.0000	0.0000	0.0000
50 KPH	.0520	32.9000	16.3000	32.6000	2.5500	.6240	.2800	1.2000	.1800	0.0000	0.0000	0.0000	0.0000	.0170
85 KPH	.1640	99.8000	7.4000	126.0000	6.7200	.6560	2.3000	4.6000	.1000	.2500	0.0000	0.0000	0.0000	.0200

[a] idle emissions per hour (/h) rather than per kilometer (/km)

VW RABBIT DIESEL PARTICULATE - DISTANCE BASIS

	VAR. 18 SI PCT	VAR. 19 CO PCT	VAR. 20 AL PCT	VAR. 21 NA PCT	VAR. 22 MG PCT	VAR. 23 K PCT	VAR. 24 CL PCT	VAR. 25 ZN PCT	VAR. 26 CU PCT	VAR. 27 NI PCT	VAR. 28 FE PCT	VAR. 29 BA PCT	VAR. 30 CA PCT	VAR. 31[a] O-CRESOL MG/KM
FUEL 238														
FTP 3BAG	0.0000	.0014	.0146	0.0000	.0061	0.0000	0.0000	.0610	0.0000	.0060	.2960	0.0000	.0700	
FTP C	0.0000	.0032	.0240	0.0000	.0071	0.0000	0.0000	.0920	0.0000	0.0000	.5300	0.0000	.0770	
FTP H	0.0000	0.0000	.0075	0.0000	.0054	0.0000	0.0000	.0370	0.0000	.0110	.1200	0.0000	.0640	
CFDS	0.0000	0.0000	.0120	0.0000	.0062	0.0000	.0060	.0690	0.0000	0.0000	.2500	0.0000	.0400	
FET	0.0000	0.0000	.0035	0.0000	.0045	0.0000	0.0000	.0750	0.0000	0.0000	.1300	0.0000	.0220	
NYCC	0.0000	.0095	0.0000	0.0000	0.0000	0.0000	0.0000	.2800	0.0000	0.0000	0.0000	0.0000	.1400	
IDLE[b]	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.2300	0.0000	0.0000	0.0000	0.0000	.1700	0.0000
50 KPH	0.0000	.0073	0.0000	0.0000	0.0000	0.0000	0.0000	.1600	.4000	.1100	0.0000	0.0000	0.0000	0.0000
85 KPH	0.0000	.0008	0.0000	0.0000	.0028	0.0000	0.0000	.0540	0.0000	0.0000	.1400	0.0000	.0210	.0140
FUEL 239														
FTP 3BAG	0.0000	.0010	.0155	0.0000	.0178	.0015	0.0000	.0650	0.0000	.0180	.4600	0.0000	.0640	
FTP C	0.0000	.0023	.0250	0.0000	.0330	.0036	0.0000	.0880	0.0000	.0190	.6200	0.0000	.0690	
FTP H	0.0000	0.0000	.0084	0.0000	.0064	0.0000	0.0000	.0470	0.0000	.0180	.3400	0.0000	.0610	
CFDS	0.0000	.0012	.0089	0.0000	.0072	.0036	0.0000	.0590	.0800	0.0000	.2700	0.0000	.0450	
FET	0.0000	0.0000	0.0000	0.0000	.0028	0.0000	0.0000	.0700	0.0000	.0500	.2000	0.0000	.0200	
NYCC	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.2600	.8100	0.0000	.1000	
IDLE[b]	0.0000	0.0000	.0310	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.3000	0.0000	.1900	0.0000
50 KPH	0.0000	0.0000	0.0000	0.0000	0.0000	.0130	0.0000	0.0000	0.0000	.1400	.4100	0.0000	.0540	0.0000
85 KPH	0.0000	0.0000	0.0000	0.0000	.0026	.0022	0.0000	.0590	0.0000	0.0000	.0960	0.0000	.0160	0.0000
FUEL 240														
FTP 3BAG	0.0000	0.0000	.0150	0.0000	.0061	.0024	0.0000	.0760	0.0000	0.0000	.4540	0.0000	.0430	
FTP C	0.0000	0.0000	.0170	0.0000	.0070	.0056	0.0000	.0610	0.0000	0.0000	.5000	0.0000	.0830	
FTP H	0.0000	0.0000	.0130	0.0000	.0054	0.0000	0.0000	.0880	0.0000	0.0000	.4200	0.0000	.1000	
CFDS	0.0000	0.0000	.0140	0.0000	.0081	.0040	0.0000	.0500	0.0000	.0220	.3600	0.0000	.0830	
FET	.0050	0.0000	.0076	0.0000	.0035	.0035	0.0000	.0440	0.0000	.0300	.2000	0.0000	.0760	
NYCC	0.0000	0.0000	0.0000	0.0000	0.0000	.0440	0.0000	0.0000	0.0000	0.0000	1.4000	0.0000	.2800	
IDLE[b]	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	3.5000	0.0000	.8000	0.0000
50 KPH	0.0000	0.0000	0.0000	0.0000	0.0000	.0230	0.0000	0.0000	0.0000	.3200	.8400	0.0000	.0490	.0050
85 KPH	.0080	0.0000	0.0000	0.0000	.0240	.0150	0.0000	.0320	0.0000	0.0000	.2000	0.0000	.0240	.0030
FUEL 241														
FTP 3BAG	.0014	.0006	.0201	0.0000	.0041	0.0000	0.0000	.0640	0.0000	.0100	.1730	0.0000	.0450	
FTP C	.0033	.0013	.0069	0.0000	.0040	0.0000	0.0000	.0290	0.0000	0.0000	.1500	0.0000	.0420	
FTP H	0.0000	0.0000	.0300	0.0000	.0042	0.0000	0.0000	.0910	0.0000	.0170	.1900	0.0000	.0460	
CFDS	0.0000	0.0000	.0038	0.0000	.0040	0.0000	0.0000	.1000	0.0000	0.0000	.1500	0.0000	.0340	
FET	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.0740	0.0000	0.0000	.0990	0.0000	.0140	
NYCC	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.0380	
IDLE[b]	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.0600	0.0000
50 KPH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.2300	0.0000	.1500	.2000	0.0000	.0340	0.0000
85 KPH	0.0000	0.0000	0.0000	0.0000	.0012	0.0000	0.0000	.0770	0.0000	.0290	.0470	0.0000	.0130	.0130
FUEL 242														
FTP 3BAG	.0044	.0052	.4625	0.0000	.0081	.0102	0.0000	.0700	0.0000	0.0000	.2520	0.0000	.3250	
FTP C	.0058	.0062	.0250	0.0000	.0083	.0120	0.0000	.0930	0.0000	0.0000	.4000	0.0000	.0670	
FTP H	.0034	.0045	.0570	0.0000	.0079	.0088	0.0000	.0520	0.0000	0.0000	.1400	0.0000	.5200	
CFDS	.0280	.0038	.0190	0.0000	.0093	.0280	0.0000	.0740	0.0000	0.0000	.2300	0.0000	.4200	
FET	.0070	0.0000	0.0000	0.0000	.0028	.0070	0.0000	0.0000	0.0000	0.0000	.1100	0.0000	.0340	
NYCC	0.0000	0.0000	0.0000	0.0000	0.0000	.0400	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
IDLE[b]	0.0000	0.0000	0.0000	0.0000	0.0000	.0210	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
50 KPH	0.0000	.0052	0.0000	0.0000	0.0000	.0210	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
85 KPH	0.0000	.0016	.0040	0.0000	.0019	.0190	0.0000	0.0000	0.0000	0.0000	.0400	0.0000	.0160	.0100

[a] plus salicylaldehyde

[b] idle emissions per hour (/h) rather than per kilometer (/km)

VW RABBIT DIESEL PARTICULATE - DISTANCE BASIS

	VAR. 32 P-CRESOL MG/KM	VAR. 33[a] 2,4-XYL MG/KM	VAR. 34[b] 2,3-XYL MG/KM	VAR. 35 100-CHNS PCT	VAR. 36 SUM VAR PCT
FUEL 238					
FTP 3BAG				24.4200	1.2810
FTP C				26.3000	1.8700
FTP H				23.0000	.8370
CFDS				18.7000	.7500
FET				24.8000	.2570
NYCC				49.3000	5.1300
IDLE[c]	.1900	0.0000	0.0000	61.3000	8.9000
50 KPH	0.0000	0.0000	0.0000	30.3000	4.1800
85 KPH	.0090	0.0000	0.0000	18.7000	.8200
FUEL 239					
FTP 3BAG				12.9700	1.9060
FTP C				27.8000	2.1800
FTP H				22.0000	1.7000
CFDS				23.0000	1.3500
FET				18.1000	1.6700
NYCC				31.0000	6.1700
IDLE[c]	.2000	0.0000	0.0000	54.1000	1.5200
50 KPH	.0050	0.0000	0.0000	29.1000	3.6200
85 KPH	0.0000	0.0000	0.0000	10.5000	1.0900
FUEL 240					
FTP 3BAG				26.5200	1.9520
FTP C				29.6000	1.4500
FTP H				24.2000	2.3300
CFDS				27.5000	1.4500
FET				28.5000	1.2400
NYCC				42.0000	8.2200
IDLE[c]	0.0000	0.0000	0.0000	55.5000	27.4000
50 KPH	.0100	0.0000	0.0000	33.8000	5.1300
85 KPH	.0120	0.0000	0.0000	18.0000	1.3000
FUEL 241					
FTP 3BAG				26.3600	.6460
FTP C				23.4000	.2540
FTP H				28.6000	.9420
CFDS				24.7000	.8170
FET				28.6000	.9890
NYCC				52.6000	2.9400
IDLE[c]	0.0000	.0700	0.0000	56.6000	.0600
50 KPH	0.0000	.0024	0.0000	35.5000	3.0300
85 KPH	.0300	0.0000	.0320	20.2000	.7440
FUEL 242					
FTP 3BAG				22.9500	1.1340
FTP C				25.4000	1.5300
FTP H				21.1000	.8360
CFDS				24.4000	.8440
FET				23.8000	.1740
NYCC				42.3000	.0710
IDLE[c]	0.0000	0.0000	0.0000	66.1000	.0710
50 KPH	.0060	0.0000	0.0000	30.7000	.0430
85 KPH	.0080	0.0000	0.0000	17.3000	.3490

[a] plus 2,5-xylenol
[b] plus 3,5-xylenol
[c] idle emissions per hour (/h) rather than per kilometer (/km)

MERCEDES 240D PARTICULATE - TIME BASIS

	VAR. 4 TOT PART G/HR	VAR. 5 PART CON MG/M3	VAR. 6 TOT SOL. PCT	VAR. 7 CARBON G/HR	VAR. 8 HYDROGEN MG/HR	VAR. 9 NITROGEN MG/HR	VAR. 10 SULFUR MG/HR	VAR. 11 SULFATE MG/HR	VAR. 12 BAP μG/HR	VAR. 13 CR PCT	VAR. 14 PB PCT	VAR. 15 MN PCT	VAR. 16 HR PCT	VAR. 17 P PCT
FUEL 238														
FTP 3BAG	10.3503	103.4000	11.2000	7.7392	294.1510	35.5498	110.1100	257.6574	12.1436	.0800	.6500	.3300	0.0000	.0118
FTP C	10.5391	104.0000	10.7000	8.1167	305.7912	42.1564	122.6940	273.7020	11.9548	0.0000	.5300	.2400	0.0000	.0160
FTP H	10.1930	103.0000	11.5000	7.4560	285.3422	30.5791	100.6720	245.3880	12.2694	.1400	.7400	.3900	0.0000	.0086
CFDS	14.6003	115.0000	7.7000	10.5727	379.8326	58.1776	229.3540	559.4000	7.2722	.0650	.2400	.1200	0.0000	.0088
FET	16.4342	113.0000	6.4000	12.0156	378.2976	49.3027	232.5600	1007.7600	5.8415	0.0000	.4800	.2200	0.0000	.0065
NYCC	7.7316	140.0000	11.4000	5.8897	201.2490	38.6580	40.9320	147.8100	21.6030	0.0000	1.7000	.9700	0.0000	0.0000
IDLE	2.9900	90.6000	9.3000	1.8800	74.8000	12.0000	31.0000	78.0000	12.0000	0.0000	3.1000	1.3000	0.0000	0.0000
50 KPH	7.5000	81.9000	10.2000	5.8500	202.5000	15.0000	60.0000	170.0000	7.0000	0.0000	.4700	0.0000	0.0000	0.0000
85 KPH	16.6600	103.0000	7.7000	12.3250	499.8000	66.6400	314.5000	816.0000	6.7150	0.0000	.4900	.2200	0.0000	.0110
FUEL 239														
FTP 3BAG	9.8784	98.9000	9.8000	7.3082	372.4864	93.3733	87.7734	235.9500	14.4716	.0600	.4400	.2100	0.0000	.0118
FTP C	10.0357	99.5000	9.7000	7.3616	361.7900	100.3574	91.2340	261.1180	16.9884	.1400	.3900	.1400	0.0000	.0160
FTP H	9.7841	98.5000	9.8000	7.2673	380.6660	88.0880	84.9420	217.0740	12.5840	0.0000	.4800	.2200	0.0000	.0087
CFDS	12.6424	99.7000	7.9000	9.2860	404.4462	354.1002	145.4440	537.0240	10.6286	0.0000	.3400	.2000	0.0000	.0088
FET	14.8838	102.0000	7.6000	10.9303	431.7864	475.4728	147.2880	643.4160	5.1938	0.0000	.9500	.5100	0.0000	.0061
NYCC	6.4240	116.0000	7.7000	5.4235	308.1270	77.0886	29.5620	77.3160	30.6990	0.0000	1.6000	.9200	0.0000	0.0000
IDLE	3.1600	45.8000	6.0000	2.5700	142.0000	69.5000	15.0000	43.0000	19.0000	0.0000	2.0000	1.1000	0.0000	0.0000
50 KPH	7.1000	77.5000	9.0000	6.2000	227.0000	135.0000	38.0000	100.0000	6.0000	0.0000	.7400	.4100	0.0000	0.0000
85 KPH	14.0250	87.0000	8.6000	10.6250	406.3000	112.2000	204.0000	663.0000	2.8050	0.0000	.5600	.2900	0.0000	.0150
FUEL 240														
FTP 3BAG	7.3931	73.9000	12.0000	5.6659	199.1418	37.5632	24.2242	66.6952	10.1616	0.0000	.6400	.2900	.0600	.1622
FTP C	7.8965	78.3000	12.2000	6.2920	221.1638	31.4600	27.6848	88.0880	11.9548	0.0000	.7800	.2800	.1500	.0340
FTP H	7.0156	70.6000	11.9000	5.1909	182.4680	42.1564	21.7074	50.3360	8.8088	0.0000	.5300	.2900	0.0000	.0280
CFDS	9.2860	73.2000	10.4000	6.8806	213.6908	83.3506	46.4302	134.2560	9.5098	0.0000	.4600	.2200	0.0000	.0390
FET	10.8528	74.4000	11.7000	9.7675	325.5840	227.9088	60.4656	186.0480	12.4032	0.0000	.7900	.3800	0.0000	.0230
NYCC	3.6043	65.3000	25.7000	2.8880	97.3272	90.0504	6.8220	17.0550	8.5275	0.0000	0.0000	0.0000	0.0000	0.0000
IDLE	1.5000	45.4000	20.1000	1.1700	63.0000	6.0000	4.7000	7.0000	9.2000	0.0000	2.2000	1.3000	0.0000	0.0000
50 KPH	5.7000	62.2000	12.7000	5.0500	62.5000	45.6000	9.5000	25.5000	2.4000	0.0000	1.2000	.6300	0.0000	.0150
85 KPH	11.5600	71.7000	9.8000	8.7550	289.0000	92.6500	34.0000	127.5000	11.9000	0.0000	.3700	.1800	0.0000	.0280
FUEL 241														
FTP 3BAG	11.9548	119.0000	7.6000	9.0656	378.4638	47.6934	120.4918	296.6678	19.5052	.0520	.3000	.1800	0.0000	.0213
FTP C	12.8357	127.0000	8.3000	9.6582	371.2280	51.2798	125.8400	302.0160	23.2804	.1200	.3300	.1900	0.0000	.0270
FTP H	11.2627	113.0000	7.0000	8.6515	383.8120	44.9878	116.4020	292.5780	16.6738	0.0000	.2700	.1800	0.0000	.0170
CFDS	14.3766	113.0000	5.5000	10.7405	402.7680	72.1626	246.1360	671.2800	8.4504	0.0000	.2200	.1400	0.0000	.0220
FET	20.0002	137.0000	4.7000	14.4962	445.7400	67.9850	240.3120	930.2400	6.6667	0.0000	.4100	.2800	0.0000	.0240
NYCC	9.1870	166.0000	3.1000	7.0153	184.1940	36.7251	62.5350	84.1380	45.4800	0.0000	.6800	.4600	0.0000	.0140
IDLE	4.0000	121.0000	4.1000	2.6700	108.0000	24.0000	31.0000	62.0000	55.0000	0.0000	0.0000	.5200	0.0000	0.0000
50 KPH	7.5000	81.9000	4.7000	6.4500	382.5000	37.5000	70.0000	140.0000	7.5000	0.0000	0.0000	0.0000	0.0000	.0081
85 KPH	19.6350	122.0000	6.0000	14.7900	667.2500	78.5400	280.5000	688.5000	2.9750	0.0000	.2400	.1400	0.0000	.0190
FUEL 242														
FTP 3BAG	9.1863	91.7000	8.9000	6.7954	242.5566	36.6824	116.4020	274.0166	7.2358	.4180	0.0000	0.0000	0.0000	.0209
FTP C	9.4065	93.3000	9.5000	7.1729	253.8822	37.7520	128.9860	232.8040	7.2358	.3500	0.0000	0.0000	0.0000	.0260
FTP H	8.9976	90.6000	8.5000	6.5122	234.0624	35.8644	106.9640	305.1620	7.2358	.4700	0.0000	0.0000	0.0000	.0170
CFDS	11.3558	89.5000	7.0000	8.1672	284.1752	45.4233	274.1060	615.3400	7.2722	.4300	0.0000	0.0000	0.0000	.0250
FET	14.0311	96.2000	2.3000	9.9226	393.0264	70.1556	263.5680	573.6480	11.5280	0.0000	0.0000	0.0000	0.0000	.0120
NYCC	6.4013	116.0000	3.9000	4.8209	166.0020	44.7478	50.0280	96.6450	8.5275	0.0000	0.0000	0.0000	0.0000	0.0000
IDLE	2.7100	82.1000	6.5000	1.7200	67.8000	19.0000	28.0000	57.0000	4.1000	0.0000	0.0000	0.0000	0.0000	0.0000
50 KPH	6.5500	71.5000	7.3000	3.9300	216.0000	45.8500	60.0000	125.0000	19.0000	0.0000	0.0000	0.0000	0.0000	.0970
85 KPH	16.5750	103.0000	4.9000	12.7500	430.9500	66.3000	348.5000	714.0000	2.3800	0.0000	0.0000	0.0000	0.0000	.0160

MERCEDES 240D PARTICULATE - TIME BASIS

	VAR. 18 SI PCT	VAR. 19 CD PCT	VAR. 20 AL PCT	VAR. 21 NA PCT	VAR. 22 MG PCT	VAR. 23 K PCT	VAR. 24 CL PCT	VAR. 25 ZN PCT	VAR. 26 CU PCT	VAR. 27 NI PCT	VAR. 28 FE PCT	VAR. 29 BA PCT	VAR. 30 CA PCT	VAR. 31[a] O-CRESOL MG/HR
FUEL 238														
FTP 3BAG	.0023	.0049	0.0000	0.0000	0.0000	0.0000	.0042	.0710	.0560	0.0000	.2530	.0014	.0230	
FTP C	.0025	.0052	0.0000	0.0000	0.0000	0.0000	.0097	.0890	0.0000	0.0000	.4300	0.0000	.0860	
FTP H	.0021	.0047	0.0000	0.0000	0.0000	0.0000	0.0000	.0570	.0990	0.0000	.1200	.0025	.0630	
CFDS	0.0000	.0025	0.0000	0.0000	0.0000	0.0000	0.0000	.0360	0.0000	0.0000	.0500	0.0000	.0250	
FET	0.0000	.0065	0.0000	0.0000	0.0000	0.0000	0.0000	.0430	0.0000	0.0000	.0780	.0190	.0390	
NYCC	0.0000	.0200	0.0000	0.0000	0.0000	0.0000	0.0000	.0790	0.0000	0.0000	0.0000	0.0000	.0390	
IDLE	0.0000	.0100	0.0000	0.0000	0.0000	0.0000	0.0000	.1300	.3500	0.0000	0.0000	0.0000	.0500	0.0000
50 KPH	0.0000	.0038	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.0420	1.4500
85 KPH	0.0000	.0039	0.0000	0.0000	0.0000	0.0000	0.0000	.0490	0.0000	0.0000	0.0000	0.0000	.0410	.5950
FUEL 239														
FTP 3BAG	.0018	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.0460	0.0000	0.0000	.1330	0.0000	.0650	
FTP C	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.0740	0.0000	0.0000	.3100	0.0000	.0630	
FTP H	.0032	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.0240	0.0000	0.0000	0.0000	0.0000	.0620	
CFDS	0.0000	.0006	0.0000	0.0000	0.0000	0.0000	0.0000	.0480	0.0000	0.0000	.0670	0.0000	.0300	
FET	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.0490	0.0000	0.0000	0.0000	0.0000	.0300	
NYCC	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
IDLE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000
50 KPH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.0470	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
85 KPH	0.0000	0.0000	.0034	.0310	0.0000	0.0000	0.0000	.0450	0.0000	0.0000	0.0000	0.0000	.0310	.9350
FUEL 240														
FTP 3BAG	.0070	.0010	.0011	.4030	0.0000	.0062	.0146	.1070	0.0000	.0090	.2430	.0065	.1220	
FTP C	.0110	.0024	0.0000	.4600	0.0000	.0100	.0340	.1200	0.0000	.0220	.3000	.0150	.1500	
FTP H	.0039	0.0000	.0020	.3600	0.0000	.0034	0.0000	.0970	0.0000	0.0000	.2000	0.0000	.1000	
CFDS	.0060	.0016	0.0000	.6200	0.0000	.0056	.0150	.0980	0.0000	.0270	.1600	.0180	.1400	
FET	.0036	.0036	0.0000	0.0000	0.0000	.0036	0.0000	.0680	0.0000	0.0000	1.0060	.0310	.1200	
NYCC	0.0000	0.0000	0.0000	0.0000	0.0000	.0260	0.0000	.1900	0.0000	0.0000	0.0000	0.0000	.1110	
IDLE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.0880	.1800	0.0000
50 KPH	.0070	0.0000	0.0000	0.0000	0.0000	.0150	0.0000	.1000	0.0000	.0440	0.0000	0.0000	.1110	0.0000
85 KPH	0.0000	0.0000	0.0000	0.0000	0.0000	.0034	0.0000	.0760	0.0000	0.0000	0.0000	0.0000	[illegible]	1.7850
FUEL 241														
FTP 3BAG	.0037	0.0000	.0021	0.0000	0.0000	.0011	0.0000	.1030	0.0000	0.0000	.2680	.0087	.0620	
FTP C	.0086	0.0000	.0048	0.0000	0.0000	.0025	0.0000	.1300	0.0000	0.0000	.4500	.0070	.0870	
FTP H	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.0820	0.0000	0.0000	.1300	.0100	.0440	
CFDS	0.0000	0.0000	0.0000	0.0000	0.0000	.0020	0.0000	.0960	0.0000	0.0000	.1000	.0093	.0410	
FET	0.0000	0.0000	.0050	0.0000	0.0000	0.0000	0.0000	.1000	0.0000	0.0000	.0950	0.0000	.0410	
NYCC	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.1100	0.0000	0.0000	0.0000	0.0000	.0460	
IDLE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.0340	0.0000
50 KPH	0.0000	0.0000	0.0000	0.0000	0.0000	.0032	0.0000	.0700	0.0000	0.0000	0.0000	0.0000	.0160	0.0000
85 KPH	0.0000	0.0000	0.0000	0.0000	0.0000	.0013	0.0000	.0740	0.0000	0.0000	.0330	0.0000	.0330	0.0000
FUEL 242														
FTP 3BAG	.0062	.0022	.0065	0.0000	0.0000	.0065	0.0000	.0670	0.0000	0.0000	.2980	0.0000	.0640	
FTP C	.0110	.0030	.0052	0.0000	0.0000	.0085	0.0000	.0920	0.0000	0.0000	.5200	0.0000	.1010	
FTP H	.0025	.0016	.0074	0.0000	0.0000	.0050	0.0000	.0440	0.0000	0.0000	.1300	0.0000	.0450	
CFDS	.0020	.0026	.0034	0.0000	0.0000	.0043	0.0000	.0740	0.0000	0.0000	.2000	0.0000	.0210	
FET	0.0000	0.0000	0.0000	0.0000	0.0000	.0063	0.0000	.0310	0.0000	0.0000	0.0000	0.0000	.0310	
NYCC	0.0000	0.0000	0.0000	0.0000	0.0000	.0029	0.0000	0.0000	0.0000	.0580	0.0000	0.0000	.0380	
IDLE	0.0000	0.0000	0.0000	0.0000	0.0000	.0250	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
50 KPH	0.0000	0.0000	0.0000	0.0000	0.0000	.0039	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
85 KPH	0.0000	.0009	0.0000	0.0000	0.0000	.0034	0.0000	.0360	0.0000	0.0000	0.0000	0.0000	.0240	.0850

[a] plus salicylaldehyde

MERCEDES 240D PARTICULATE - TIME BASIS

	VAR. 32 P-CRESOL MG/HR	VAR. 33[a] 2,4-XYL MG/HR	VAR. 34[b] 2,3-XYL MG/HR	VAR. 35 100-CHNS PCT	VAR. 36 SUM VAR PCT
FUEL 238					
FTP 3BAG				20.9500	1.5350
FTP C				18.5000	1.4100
FTP H				22.8000	1.6300
CFDS				23.0000	.5470
FET				24.3000	.8920
NYCC				20.2000	2.8100
IDLE	0.0000	0.0000	0.0000	33.2000	4.9400
50 KPH	.7500	0.0000	0.0000	18.3000	.5110
85 KPH	.5100	0.0000	0.0000	20.7000	.8150
FUEL 239					
FTP 3BAG				20.5300	.9650
FTP C				21.1000	1.1800
FTP H				20.1000	.8030
CFDS				19.4000	.6940
FET				19.5000	1.5500
NYCC				9.1200	2.5200
IDLE	0.0000	0.0000	0.0000	11.5000	3.1000
50 KPH	0.0000	0.0000	0.0000	7.0400	1.2000
85 KPH	1.0200	0.0000	0.0000	19.1000	.9750
FUEL 240					
FTP 3BAG				20.0500	1.9370
FTP C				16.8000	2.3700
FTP H				22.5000	1.6100
CFDS				22.2000	1.8100
FET				4.3400	2.4200
NYCC				14.5000	.3260
IDLE	0.0000	0.0000	0.0000	17.1000	3.7700
50 KPH	0.0000	0.0000	0.0000	9.3400	2.1100
85 KPH	.5950	0.0000	0.0000	20.7000	.7560
FUEL 241					
FTP 3BAG				19.2500	1.0030
FTP C				20.5000	1.3600
FTP H				18.3000	.7330
CFDS				20.3000	.6300
FET				23.8000	.9550
NYCC				20.6000	1.3100
IDLE	0.0000	0.0000	0.0000	29.2000	.5590
50 KPH	0.0000	0.0000	0.0000	7.5000	.0970
85 KPH	0.0000	0.0000	0.0000	19.5000	.5400
FUEL 242					
FTP 3BAG				21.6400	.8940
FTP C				19.3000	1.1200
FTP H				23.4000	.7230
CFDS				22.8000	.8120
FET				24.1000	.0800
NYCC				20.6000	.1040
IDLE	0.0000	0.0000	0.0000	32.3000	.0250
50 KPH	0.0000	0.0000	0.0000	35.1000	.1010
85 KPH	.3400	0.0000	0.0000	18.0000	.0900

[a] plus 2,5-xylenol
[b] plus 3,5-xylenol

VW RABBIT DIESEL PARTICULATE - TIME BASIS

	VAR. 4 TOT PART G/HR	VAR. 5 PART CON MG/M3	VAR. 6 TOT SOL. PCT	VAR. 7 CARBON G/HR	VAR. 8 HYDROGEN MG/HR	VAR. 9 NITROGEN MG/HR	VAR. 10 SULFUR MG/HR	VAR. 11 SULFATE MG/HR	VAR. 12 BAP µG/HP	VAR. 13 CR PCT	VAR. 14 PB PCT	VAR. 15 MN PCT	VAR. 16 BR PCT	VAR. 17 P PCT
FUEL 238														
FTP 3BAG	7.0785	80.2000	10.8000	4.9581	279.3648	28.2825	65.7514	198.1980	35.5813	0.0000	.5300	.2700	0.0000	.0229
FTP C	7.9279	86.9000	12.2000	5.4426	301.3868	31.7746	69.2120	248.5340	59.7740	0.0000	.7400	.3700	0.0000	.0240
FTP H	6.4178	75.1000	9.8000	4.5932	263.0056	25.6714	62.9200	160.4460	17.3030	0.0000	.3700	.2000	0.0000	.0220
CFDS	11.5236	105.0000	14.6000	8.6148	506.8164	69.3656	174.0080	514.6480	20.1384	.1500	.1900	0.0000	0.0000	.0270
FET	13.4110	105.0000	9.1000	9.3799	482.4496	53.6438	170.5440	542.6400	30.2328	0.0000	0.0000	0.0000	0.0000	.0220
NYCC	4.1273	86.6000	14.4000	1.9329	128.4810	8.2546	22.7400	68.2200	19.3290	0.0000	3.2000	1.5000	0.0000	0.0000
IDLE	1.4300	49.5000	10.0000	.6290	77.2000	23.2000	18.0000	44.0000	4.5000	0.0000	5.7000	2.6000	0.0000	0.0000
50 KPH	4.5000	56.9000	14.9000	2.7200	261.0000	36.0000	18.0000	70.0000	17.0000	0.0000	2.4000	1.1000	0.0000	0.0000
85 KPH	14.1950	102.0000	14.0000	10.7100	553.3500	70.4250	204.0000	552.5000	21.2500	0.0000	.3900	.1400	0.0000	.0210
FUEL 239														
FTP 3BAG	6.8583	77.8000	13.2000	4.7505	288.4882	65.2480	49.0776	162.6482	41.8733	0.0000	.8000	.4300	0.0000	.0306
FTP C	7.8650	86.2000	11.6000	5.2538	298.8700	62.4200	54.7740	195.0520	72.3580	0.0000	.8400	.4500	0.0000	.0340
FTP H	6.1032	71.4000	14.4000	4.3729	280.6232	67.0098	40.8980	138.4240	18.8760	0.0000	.7700	.4200	0.0000	.0280
CFDS	10.8524	98.8000	13.2000	7.8316	293.1256	119.1522	111.8800	397.1740	21.8166	0.0000	.5700	.2800	0.0000	.0280
FET	11.0854	86.6000	14.3000	8.3722	510.0816	100.0008	93.0240	341.0880	19.3800	0.0000	.8400	.4700	0.0000	.0200
NYCC	4.3661	91.6000	27.5000	2.5924	332.0040	74.2461	14.7810	48.8910	18.1420	0.0000	3.1000	1.9000	0.0000	0.0000
IDLE	2.1200	54.4000	18.4000	.7480	174.0000	38.2000	14.0000	70.0000	5.3000	0.0000	0.0000	0.0000	0.0000	0.0000
50 KPH	3.4000	43.0000	22.7000	2.0800	275.5000	44.2000	12.0000	45.0000	16.5000	0.0000	1.9000	1.1000	0.0000	0.0000
85 KPH	12.5800	90.1000	12.7000	10.4550	566.1000	113.0500	127.5000	425.0000	18.7000	0.0000	.5900	.3100	0.0000	.0160
FUEL 240														
FTP 3BAG	5.5684	62.9000	15.0000	3.8350	185.9286	13.9368	21.3928	73.9310	37.0913	0.0000	.8400	.4300	0.0000	.0393
FTP C	6.5751	72.1000	13.2000	4.3724	210.4674	14.4716	31.4600	113.2560	62.9200	0.0000	.4900	.2500	0.0000	.0330
FTP H	4.7819	55.9000	16.4000	3.4291	167.3672	13.5278	13.8424	44.0440	17.6176	0.0000	1.1000	.5600	0.0000	.0440
CFDS	8.3351	75.9000	15.2000	5.6499	341.7934	23.4968	25.1730	128.6620	67.1280	0.0000	.5600	.3000	0.0000	.0500
FET	10.6978	83.6000	15.3000	7.1473	449.6160	24.8064	27.9072	77.5200	67.4424	0.0000	.5500	.3100	0.0000	.0150
NYCC	3.3541	70.4000	18.7000	1.8078	120.5220	12.5020	3.1836	47.7540	3.9795	0.0000	4.0000	2.5000	0.0000	0.0000
IDLE	.7420	19.0000	19.6000	.3030	21.5000	4.0000	1.5000	12.0000	0.0000	0.0000	15.0000	8.1000	0.0000	0.0000
50 KPH	2.3500	29.7000	15.7000	1.4300	115.0000	9.0000	1.5000	16.0000	.9500	0.0000	2.4000	1.5000	0.0000	0.0000
85 KPH	8.7550	62.7000	13.4000	6.8255	315.3500	22.1000	20.4000	119.0000	62.9000	0.0000	.6400	.3300	0.0000	.0240
FUEL 241														
FTP 3BAG	11.7975	132.3000	15.6000	8.1104	587.3582	51.3742	61.0324	251.9946	114.4200	0.0000	.1800	.1300	0.0000	.0227
FTP C	17.7749	195.0000	11.8000	12.5211	940.6540	71.0996	75.5040	346.0600	220.2200	0.0000	0.0000	0.0000	0.0000	.0170
FTP H	7.2673	85.0000	18.4000	4.7819	320.8920	36.4436	51.3360	160.4460	34.6060	0.0000	.3200	.2200	0.0000	.0270
CFDS	12.4187	113.0000	15.4000	8.6707	484.4404	62.0934	128.6620	447.5200	40.8362	0.0000	.3000	.2000	0.0000	.0250
FET	13.4885	105.0000	15.4000	9.6900	485.2752	53.4539	116.2800	387.6000	31.7832	0.0000	.4600	.3200	0.0000	.0220
NYCC	5.1165	107.0000	18.0000	2.2399	122.7960	46.0485	15.9180	86.4120	17.0550	0.0000	1.8000	1.1000	0.0000	0.0000
IDLE	2.8400	72.8000	16.3000	1.0700	125.0000	19.9000	17.0000	110.0000	4.8000	0.0000	0.0000	0.0000	0.0000	0.0000
50 KPH	9.8500	125.0000	15.4000	5.5500	760.0000	29.5500	18.0000	55.0000	4.8000	0.0000	1.4000	1.0000	0.0000	.0140
85 KPH	16.0650	115.0000	21.6000	12.0700	546.5500	96.0500	110.5000	416.5000	27.2000	0.0000	.3300	.2300	0.0000	.0170
FUEL 242														
FTP 3BAG	6.1032	69.2000	13.6000	4.3478	241.6128	36.7453	68.2682	125.8400	32.9701	.3740	0.0000	0.0000	0.0000	.0433
FTP C	6.9527	76.2000	13.5000	4.8134	264.2640	34.6060	75.5040	163.5920	56.6280	.8700	0.0000	0.0000	0.0000	.0450
FTP H	5.4740	64.0000	13.7000	3.9954	224.3098	38.3812	62.9200	97.5260	15.1008	0.0000	0.0000	0.0000	0.0000	.0420
CFDS	8.7266	79.4000	14.3000	6.0415	358.0160	43.6342	156.6320	374.7980	16.7820	0.0000	0.0000	0.0000	0.0000	.0320
FET	13.5660	106.0000	12.9000	9.6125	556.5936	67.8400	100.7760	581.4000	31.0080	0.0000	0.0000	0.0000	0.0000	.0130
NYCC	4.5707	95.9000	11.6000	2.3763	210.3450	36.6114	14.7810	55.7130	15.9180	0.0000	0.0000	0.0000	0.0000	.0310
IDLE	2.1000	53.8000	11.4000	.5610	107.0000	29.4000	14.0000	54.0000	3.5000	0.0000	0.0000	0.0000	0.0000	0.0000
50 KPH	2.6000	32.9000	16.3000	1.6300	127.5000	31.2000	14.0000	60.0000	9.0000	0.0000	0.0000	0.0000	0.0000	.0170
85 KPH	13.9400	99.8000	7.4000	10.7100	571.2000	55.7600	195.5000	391.0000	8.5000	.2500	0.0000	0.0000	0.0000	.0200

VW RABBIT DIESEL PARTICULATE - TIME BASIS

	VAR. 18 SI PCT	VAR. 19 CD PCT	VAR. 20 AL PCT	VAR. 21 NA PCT	VAR. 22 MG PCT	VAR. 23 K PCT	VAR. 24 CL PCT	VAR. 25 ZN PCT	VAR. 26 CU PCT	VAR. 27 NI PCT	VAR. 28 FE PCT	VAR. 29 BA PCT	VAR. 30 LA PCT	VAR. 31[a] O-CRESOL MG/MR
FUEL 238														
FTP 3BAG	0.0000	.0014	.0146	0.0000	.0061	0.0000	0.0000	.0610	0.0000	.0060	.2960	0.0000	.0200	
FTP C	0.0000	.0032	.0240	0.0000	.0071	0.0000	0.0000	.0920	0.0000	0.0000	.5300	0.0000	.0270	
FTP H	0.0000	0.0000	.0075	0.0000	.0054	0.0000	0.0000	.0370	0.0000	.0110	.1200	0.0000	.0640	
CFDS	0.0000	0.0000	.0120	0.0000	.0062	0.0000	.0060	.0690	0.0000	0.0000	.2500	0.0000	.0400	
FET	0.0000	0.0000	.0035	0.0000	.0045	0.0000	0.0000	.0750	0.0000	0.0000	.1300	0.0000	.0220	
NYCC	0.0000	.0095	0.0000	0.0000	0.0000	0.0000	0.0000	.2800	0.0000	0.0000	0.0000	0.0000	.1400	
IDLE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.2300	0.0000	0.0000	0.0000	0.0000	.1200	0.0000
50 KPH	0.0000	.0073	0.0000	0.0000	0.0000	0.0000	0.0000	.1600	.4000	.1100	0.0000	0.0000	0.0000	0.0000
85 KPH	0.0000	.0008	0.0000	0.0000	.0028	0.0000	0.0000	.0540	0.0000	0.0000	.1400	0.0000	.0210	1.1400
FUEL 239														
FTP 3BAG	0.0000	.0010	.0155	0.0000	.0178	.0015	0.0000	.0650	0.0000	.0180	.4600	0.0000	.0640	
FTP C	0.0000	.0023	.0250	0.0000	.0330	.0036	0.0000	.0880	0.0000	.0190	.6200	0.0000	.0640	
FTP H	0.0000	0.0000	.0084	0.0000	.0064	0.0000	0.0000	.0470	0.0000	.0180	.3400	0.0000	.0610	
CFDS	0.0000	.0012	.0089	0.0000	.0072	.0036	0.0000	.0590	.0800	0.0000	.2700	0.0000	.0450	
FET	0.0000	0.0000	0.0000	0.0000	.0028	0.0000	0.0000	.0700	0.0000	.0500	.2000	0.0000	.0200	
NYCC	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.2600	.8100	0.0000	.1000	
IDLE	0.0000	0.0000	.0310	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.3000	0.0000	.1300	0.0000
50 KPH	0.0000	0.0000	0.0000	0.0000	0.0000	.0130	0.0000	0.0000	0.0000	.1400	.4100	0.0000	.0540	0.0000
85 KPH	0.0000	0.0000	0.0000	0.0000	.0026	.0022	0.0000	.0590	0.0000	0.0000	.0960	0.0000	.0160	0.0000
FUEL 240														
FTP 3BAG	0.0000	0.0000	.0150	0.0000	.0061	.0024	0.0000	.0760	0.0000	0.0000	.4540	0.0000	.0930	
FTP C	0.0000	0.0000	.0170	0.0000	.0070	.0056	0.0000	.0610	0.0000	0.0000	.5000	0.0000	.0830	
FTP H	0.0000	0.0000	.0130	0.0000	.0054	0.0000	0.0000	.0880	0.0000	0.0000	.4200	0.0000	.1000	
CFDS	0.0000	0.0000	.0140	0.0000	.0081	.0040	0.0000	.0500	0.0000	.0220	.3600	0.0000	.0830	
FET	.0050	0.0000	.0076	0.0000	.0035	.0035	0.0000	.0440	0.0000	.0300	.2000	0.0000	.0760	
NYCC	0.0000	0.0000	0.0000	0.0000	0.0000	.0440	0.0000	0.0000	0.0000	0.0000	1.4000	0.0000	.2800	
IDLE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	3.5000	0.0000	.8000	0.0000
50 KPH	0.0000	0.0000	0.0000	0.0000	0.0000	.0230	0.0000	0.0000	0.0000	.3200	.8400	0.0000	.0490	.2500
85 KPH	.0080	0.0000	0.0000	0.0000	.0240	.0150	0.0000	.0320	0.0000	0.0000	.2000	0.0000	.0240	.2550
FUEL 241														
FTP 3BAG	.0014	.0006	.0201	0.0000	.0041	0.0000	0.0000	.0640	0.0000	.0100	.1730	0.0000	.0450	
FTP C	.0033	.0013	.0069	0.0000	.0040	0.0000	0.0000	.0290	0.0000	0.0000	.1500	0.0000	.0420	
FTP H	0.0000	0.0000	.0300	0.0000	.0042	0.0000	0.0000	.0910	0.0000	.0170	.1900	0.0000	.0480	
CFDS	0.0000	0.0000	.0038	0.0000	.0040	0.0000	0.0000	.1000	0.0000	0.0000	.1500	0.0000	.0340	
FET	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.0740	0.0000	0.0000	.0990	0.0000	.0140	
NYCC	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.0380	
IDLE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.0600	0.0000
50 KPH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.2300	0.0000	.1500	.2000	0.0000	.0340	0.0000
85 KPH	0.0000	0.0000	0.0000	0.0000	.0012	0.0000	0.0000	.0770	0.0000	.0290	.0470	0.0000	.0130	1.1050
FUEL 242														
FTP 3BAG	.0044	.0052	.4625	0.0000	.0081	.0102	0.0000	.0700	0.0000	0.0000	.2520	0.0000	.3250	
FTP C	.0058	.0062	.0250	0.0000	.0083	.0120	0.0000	.0930	0.0000	0.0000	.4000	0.0000	.0670	
FTP H	.0034	.0045	.0570	0.0000	.0079	.0088	0.0000	.0520	0.0000	0.0000	.1400	0.0000	.5200	
CFDS	.0280	.0038	.0190	0.0000	.0093	.0280	0.0000	.0740	0.0000	0.0000	.2300	0.0000	.4200	
FET	.0070	0.0000	0.0000	0.0000	.0028	.0070	0.0000	0.0000	0.0000	0.0000	.1100	0.0000	.0340	
NYCC	0.0000	0.0000	0.0000	0.0000	0.0000	.0400	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
IDLE	0.0000	0.0000	0.0000	0.0000	0.0000	.0710	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
50 KPH	0.0000	.0052	0.0000	0.0000	0.0000	.0210	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
85 KPH	0.0000	.0016	.0040	0.0000	.0019	.0190	0.0000	0.0000	0.0000	0.0000	.0400	0.0000	.0160	.8500

[a] plus salicylaldehyde

VW RABBIT DIESEL PARTICULATE - TIME BASIS

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             VAR. 32 VAR. 33aVAR. 34bVAR. 35 VAR. 36
             P-CRESOL  2,4-XYL  2,3-XYL 100-CHNS  SUM VAR
               MG/HR    MG/HR    MG/HR      PCT      PCT
             -------- -------- -------- -------- --------

FUEL 238
 FTP 3BAG                               24.4200   1.2810
 FTP C                                  26.3000   1.8700
 FTP H                                  23.0000    .8370
 CFDS                                   18.7000    .7500
 FET                                    24.8000    .2570
 NYCC                                   49.3000   5.1300
 IDLE          .1900   0.0000   0.0000  61.3000   8.9000
 50 KPH       0.0000   0.0000   0.0000  30.3000   4.1800
 85 KPH        .7650   0.0000   0.0000  18.7000    .8200

FUEL 239
 FTP 3BAG                               12.9700   1.9060
 FTP C                                  27.3000   2.1800
 FTP H                                  22.0000   1.7000
 CFDS                                   23.0000   1.3500
 FET                                    18.1000   1.6700
 NYCC                                   31.0000   6.1700
 IDLE          .2000   0.0000   0.0000  54.1000   1.5200
 50 KPH        .2500   0.0000   0.0000  29.1000   3.6200
 85 KPH       0.0000   0.0000   0.0000  10.5000   1.0900

FUEL 240
 FTP 3BAG                               26.5200   1.9520
 FTP C                                  29.6000   1.4500
 FTP H                                  24.2000   2.3300
 CFDS                                   27.5000   1.4500
 FET                                    28.5000   1.2400
 NYCC                                   42.0000   8.2200
 IDLE         0.0000   0.0000   0.0000  55.5000  27.4000
 50 KPH        .5000   0.0000   0.0000  33.8000   5.1300
 85 KPH       1.0200   0.0000   0.0000  18.0000   1.3000

FUEL 241
 FTP 3BAG                               26.3600    .6460
 FTP C                                  23.4000    .2540
 FTP H                                  28.6000    .9420
 CFDS                                   24.7000    .8170
 FET                                    28.6000    .9890
 NYCC                                   52.6000   2.9400
 IDLE         0.0000    .0700   0.0000  56.6000    .0600
 50 KPH       0.0000    .1200   0.0000  35.5000   3.0300
 85 KPH       2.5500   0.0000   2.7200  20.2000    .7440

FUEL 242
 FTP 3BAG                               22.9500   1.1340
 FTP C                                  25.4000   1.5300
 FTP H                                  21.1000    .8360
 CFDS                                   24.4000    .8440
 FET                                    23.8000    .1740
 NYCC                                   42.3000    .0710
 IDLE         0.0000   0.0000   0.0000  66.1000    .0710
 50 KPH        .3000   0.0000   0.0000  30.7000    .0430
 85 KPH        .6800   0.0000   0.0000  17.3000    .3490
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[a] plus 2,5-xylenol
[b] plus 3,5-xylenol

PERCENT OF TOTAL PARTICULATE COLLECTED

TEST TYPE	STAGE 1	STAGE 2	STAGE 3	STAGE 4	STAGE 5	STAGE 6	STAGE 7	STAGE 8	STAGE 9	TOTAL PARTICULATE
M238FTPC	.704	.241	2.762	2.354	2.929	3.800	3.577	3.707	79.926	5.395
M238FTPH	.524	.691	1.024	1.691	2.358	2.859	3.192	3.597	84.064	4.198
M238FTPH	.570	.386	1.488	3.399	1.984	2.811	3.178	4.042	82.142	5.443
M238CFDS	.249	.762	1.508	1.508	3.265	3.563	4.110	4.325	80.709	6.034
M238CFDS	.619	.777	1.428	1.713	2.554	3.268	3.997	3.331	82.313	6.304
M238FET	.109	.136	.544	1.088	.816	2.177	3.129	3.837	88.163	3.675
M238FET	.198	.912	2.661	3.117	2.843	3.497	3.801	4.896	78.075	6.577
M238NYCC	.302	.378	.983	1.512	1.965	2.570	2.041	2.948	87.302	1.323
M238NYCC	2.646	3.491	5.293	6.081	5.349	6.644	6.081	.225	64.189	1.776
M238IDLE	2.584	1.034	0.000	.431	2.153	1.723	2.584	3.015	86.477	1.161
M23850KH	.615	.707	.615	.769	1.383	1.691	2.306	2.920	88.995	3.253
M23885KH	.166	.217	.447	.447	1.291	2.237	3.771	3.618	87.805	7.823
M239FTPC	.178	.355	2.073	1.659	2.192	3.061	3.495	3.752	83.235	5.064
M239FTPC	.181	.905	2.155	1.739	2.517	4.147	3.821	4.219	80.315	5.522
M239FTPC	.872	1.316	2.758	2.580	2.544	4.270	4.270	3.469	77.922	5.621
M239FTPH	.121	.202	1.130	1.271	1.735	2.663	2.925	4.015	85.939	4.957
M239FTPH	.220	.549	1.445	1.628	1.848	2.689	3.037	3.458	85.126	5.466
M234FTPH	1.112	1.074	1.612	1.834	2.056	2.797	3.409	3.649	82.456	5.398
M239CFDS	.043	.144	.852	.939	1.906	3.278	3.972	4.116	84.749	6.924
M239CFDS	.332	.608	.622	1.935	2.404	3.095	3.537	3.938	83.529	7.237
M239FET	.148	.211	.781	.992	1.351	2.723	3.040	3.673	87.080	4.737
M239NYCC	.285	.142	.570	1.425	1.638	1.852	3.917	3.561	86.610	1.404
M239IDLE	.216	.288	.935	.791	.647	1.583	1.655	2.518	91.367	1.390
M23950KH	.547	.486	.456	.486	.912	1.003	2.279	2.522	91.310	3.291
M23985KH	.716	.351	.506	.955	1.461	2.459	3.386	3.512	86.654	7.118
M240FTPC	.045	.697	2.361	1.574	1.799	3.462	3.327	3.372	83.363	4.448
M240FTPC	.434	.976	3.188	2.928	2.364	4.446	2.971	2.928	79.766	4.611
M240FTPC	.096	.239	1.745	1.817	2.199	2.988	2.295	2.988	85.632	4.183
M240FTPH	.075	.401	1.403	1.578	2.004	2.255	2.756	3.257	86.273	3.992
M240FTPH	.149	1.294	2.040	1.767	1.866	2.339	2.239	2.961	85.345	4.019
M240FTPH	.128	.461	1.383	1.280	1.844	3.227	2.433	3.227	86.018	3.905
M240CFDS	.243	.417	1.704	2.000	2.260	4.086	3.356	3.634	82.299	5.751
M240CFDS	.057	.757	1.249	1.665	2.252	3.444	3.595	3.822	83.160	5.285
M240FET	.026	.132	.924	.818	1.188	2.376	2.904	3.247	88.384	3.788
M240NYCC	.229	.801	1.144	1.716	2.288	2.860	2.860	4.577	83.524	.874
M240IDLE	.939	1.761	2.347	3.286	3.169	2.465	4.343	3.286	78.404	.852
M24050KH	.116	.233	.194	.310	1.125	1.513	1.862	2.483	92.164	2.578
M24050KH	.398	1.014	.326	.181	1.412	2.245	2.571	2.643	89.211	2.762
M24085KH	.097	.697	.600	.568	1.379	1.768	2.303	3.228	89.359	6.165
M241FTPC	.343	.847	2.220	2.583	2.603	3.914	4,379	4.237	78.874	4.956
M241FTPC	.579	.781	2.531	2.314	2.459	3.891	3.949	4.484	79.011	6.413
M241FTPH	.587	.696	1.546	2.010	1.901	2.149	3.478	3.911	83.722	6.469
M241FTPH	.642	.944	.698	1.510	2.189	3.208	3.869	4.189	82.751	5.299
M241FTPH	.236	.253	1.515	1.431	1.566	3.435	3.671	4.243	83.650	5.439
M241CFDS	.082	.424	1.824	1.871	3.247	4.353	4.895	4.883	78.421	8.499
M241CFDS	.289	.602	2.108	2.385	2.530	3.975	4.457	4.878	78.776	8.302
M241FET	.111	.185	3.022	.945	1.947	1.872	2.688	3.689	85.539	5.394
M241FET	.152	1.347	1.566	.673	3.098	3.906	4.040	3.906	81.313	5.940
M241NYCC	1.408	1.199	3.026	3.754	2.503	4.484	3.441	4.275	75.860	1.918
M241IDLE	2.445	1.246	.719	1.198	2.205	2.061	2.253	3.787	84.084	2.086
M24150KH	.561	1.096	1.444	1.203	1.845	2.620	2.941	3.449	84.840	3.740
M24185KH	.468	.563	.712	.532	1.116	2.360	3.370	3.976	86.903	9.407
M24185KH	.427	.778	1.030	1.183	.383	2.564	3.067	4.130	86.437	9.128
M242FTPC	.310	.989	2.811	2.404	2.889	3.974	3.658	3.761	79.003	5.158
M242FTPC	.504	1.051	2.837	3.467	2.942	3.593	2.942	3.782	78.882	4.759
M242FTPC	.799	.778	3.762	3.342	4.098	3.762	3.783	3.657	76.019	4.758
M242FTPH	.307	.482	1.424	1.774	1.972	2.738	3.154	3.614	84.535	4.565
M242FTPH	.299	.896	2.289	2.015	2.687	2.737	2.986	3.558	82.533	4.019

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                              PERCENT OF TOTAL PARTICULATE COLLECTED

M242FTPH     .632      .843     2.444     2.212     2.233     2.928     2.528     3.076    83.105        4.747
M242CFDS     .360      .677     2.522     2.248     2.739     4.281     4.526     4.901    77.746        6.938
M242CFDS     .170      .648     2.316     2.343     2.254     4.029     3.396     4.291    80.503        6.478
M242FET      .114      .182     1.249     1.499     1.840     2.839     3.611     3.725    84.942        4.403
M242NYCC    1.231     1.642     2.394     2.736     2.668     4.241     2.668     3.078    79.343        1.462
M242IDLE    1.157      .926      .231     1.505     2.546     3.009     4.514     5.324    80.787         .864
M242IDLE    0.000     2.949     1.410      .256      .385     4.872     6.923    10.128    73.077         .780
M24250KH     .401      .681      .601      .962     1.402     1.603     2.885     3.926    87.540        2.496
M24250KH     .326      .587      .652      .261     0.000     1.304     1.630     1.500    93.740        3.067
M24285KH     .049      .210      .618      .741      .717     2.064     4.041     3.497    88.064        8.093
V238FTPC     .803     1.043     3.344     4.013     3.531     5.243     5.993     4.280    71.750        3.738
V238FTPC     .459      .275     3.090     2.906     3.151     3.610     3.487     2.294    80.728        3.269
V238FTPC     .734     1.685     3.672     3.672     3.909     5.918     3.564     4.082    72.765        4.630
V238FTPH    1.657     1.983     5.031     4.291     6.215     6.748     4.735     3.463    65.877        3.379
V238FTPH     .789     1.076     1.076     2.691     2.332     2.763     2.512     2.799    83.961        2.787
V238FTPH    2.194     2.366     4.946     1.720     5.075     4.946     5.161     8.387    65.204        2.325
V238CFDS     .847     1.334     3.922     3.295     3.436     5.868     5.726     4.079    71.494        6.374
V238CFDS    1.048     1.108     2.905     3.325     3.669     5.002     4.778     3.879    74.285        6.677
V238FET      .862      .412     5.208     1.424     2.435     2.435     3.972     2.435    80.817        2.669
V238NYCC    1.195     2.151     4.062     2.987     2.270     6.571     4.301     5.376    71.087         .837
V23850KH    1.554      .104      .466      .207      .621     1.243     1.554     1.295    92.957        1.931
V239FTPC     .631     1.237     3.813     3.662     4.040     6.313     5.051     3.737    71.515        3.960
V239FTPC    1.227     2.432     4.641     3.994     3.748     6.560     6.270     4.529    66.600        4.482
V239FTPC     .138      .992     3.170     3.087     2.674     3.886     3.583     2.784    79.686        3.628
V239FTPC    1.647     2.423     3.129     3.529     4.352     4.470     3.599     4.705    72.148        4.251
V239FTPH    1.531     1.065     2.197     1.298     2.630     3.728     2.497     1.997    83.056        3.004
V239FTPH    0.000     1.271     2.401     3.362     3.220     6.215     4.153     3.955    75.424        3.540
V239FTPH     .103      .241     1.551     1.413     2.068     2.482     2.275     2.482    87.384        2.901
V239CFDS     .475     1.055     1.846     1.899     2.567     3.007     3.886     3.552    81.713        5.687
V239CFDS     .978     1.088     3.313     3.739     4.638     5.521     4.953     3.975    71.794        6.339
V239FET      .599      .180     1.228     1.018     1.497     1.946     1.467     1.946    90.120        3.340
V239NYCC     .302     2.920     1.511     3.021     5.740     4.632     4.632     2.820    74.421         .993
V239IDLE     .175      .262      .349      .436     2.007      .698      .698     1.134    94.241        1.146
V239IDLE     .234     1.170      .351      .351      .585     1.170     1.754     2.222    92.164         .855
V23950KH    1.483     1.922      .824     1.318     1.043     1.757     1.208     2.526    87.919        1.821
V23985KH     .407      .407      .678      .753     1.130     2.259     2.410     2.711    89.245        6.639
V240FTPC    1.062     1.717     3.965     3.746     2.872     5.058     3.028     2.061    76.491        3.203
V240FTPC     .621     2.267     3.104     4.318     5.182     5.533     4.777     4.022    70.175        3.705
V240FTPC     .091      .607     3.551     2.549     2.883     4.492     2.428     2.215    81.184        3.295
V240FTPH     .504     1.007     2.751     2.015     2.596     4.262     2.751     2.441    81.674        2.581
V240FTPH     .114      .151     1.703     1.967     2.119     3.178     2.459     1.097    87.212        2.643
V240FTPH    0.000      .347     2.062      .991     1.983     2.736     1.190     1.507    89.136        2.522
V240CFDS     .643     1.165     3.697     3.878     3.958     5.726     4.320     3.215    73.398        4.977
V240CFDS     .492     1.083     3.368     2.935     3.348     4.786     2.462     2.955    78.570        5.077
V240FET      .865      .961     1.761     1.441     1.601     2.273     1.729     1.633    87.736        3.123
V240FET     1.431     1.113     1.908     1.272     1.335     1.749     1.590     2.003    87.599        3.145
V240NYCC    4.697     3.914     4.305     1.566     1.761     5.088     1.957     5.284    71.429         .511
V240NYCC     .504     3.657     4.792     5.675     9.206     5.675     3.026     2.522    64.943         .793
V240IDLE     .552     5.525     1.105     2.762     2.486      .552     2.486     2.762    81.768         .362
V24050KH     .148     0.000      .148      .296      .370      .665     1.330     2.217    94.826        1.353
V24085KH     .151      .108      .710      .473      .989      .925     1.527     1.613    93.504        4.649
V241FTPC     .984     3.539     3.694     3.314     4.022     5.351     4.316     4.488    70.292        5.793
V241FTPC     .182      .404     1.421     1.955     2.086     3.193     2.542     4.901    83.316        7.672
V241FTPC     .535      .535     1.606     1.475     2.035     2.499     3.367    10.352    77.594        8.404
V241FTPC     .664      .701     1.491     1.595     1.931     3.318     2.848    11.370    76.083       13.413
V241FTPC     .041     2.745     2.635      .773     2.387     1.945     3.131     9.284    77.059        7.249
V241FTPH     .989     1.126     2.499     4.834     2.417     3.158     2.444     2.472    80.060        3.641
V241FTPH     .691      .740     1.776     1.974     2.221     3.578     2.541     2.467    84.012        4.053
V241FTPH     .459     1.148     3.572     2.041     3.572     3.343     2.169     2.169    81.526        3.919
V241CFDS     .542     1.006     1.935     1.610     2.013     3.019     3.096     3.871    82.908        6.459
V241CFDS     .848     1.002     3.270     2.390     2.576     3.239     2.977     3.316    80.382        6.484
V241FET      .492      .246      .763     1.231     1.649     2.757     2.462     3.053    87.346        4.062
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                                    PERCENT OF TOTAL PARTICULATE COLLECTED
V241NYCC     1.103     2.279     2.574     1.544     2.206     1.544     1.397      .809    86.544        1.360
V241NYCC     1.667      .965     8.596     6.404      .439     1.491     1.842     2.281    76.316        1.140
V241IDLE      .905      .251     1.055     1.910      .151      .754      .101      .603    94.271        1.990
V241IDLE     2.244     1.273     1.334     5.094      .728      .546      .121      .424    88.235        1.649
V24150KH      .571      .394      .709      .512      .099      .591      .985     1.872    94.266        5.075
V24150KH      .034      .015      .063      .073      .068      .044      .213     5.285    94.207       20.662
V24185KH      .325      .377      .911      .896     1.171     2.056     2.733     2.863    88.717        7.684
V24185KH      .052      .273      .599      .403      .677     1.380     2.720     5.558    88.338        7.683
V242FTPC      .137      .581     1.640     2.426     2.597     4.202     2.494     3.006    82.918        2.927
V242FTPC     1.299     2.732     3.031     3.264     3.698     5.463     4.830     3.664    72.019        3.002
V242FTPC      .154     1.907     4.459     3.936     4.459     4.520     3.536     3.383    73.647        3.252
V242FTPC     1.079     2.287     3.109     2.852     4.625     5.036     4.625     3.983    72.405        3.892
V242FTPH      .766     1.997     2.929     3.495     3.196     4.361     3.395     3.129    76.731        3.004
V242FTPH     1.339     1.339     2.418     2.504     2.159     4.836     1.727     1.770    81.908        2.316
V242FTPH      .410     1.230     1.790     1.864     2.274     4.698     3.840     3.691    80.201        2.682
V242FTPH      .562     1.059     1.952     1.985     4.300     5.293     3.473     3.143    78.234        3.023
V242CFDS      .062     1.143     2.203     1.247     1.538     2.390     2.453     2.245    86.718        4.811
V242FET       .085      .285     1.453     1.253     1.652     2.905     2.250     2.991    87.126        3.511
V242FET       .746      .969     1.815     1.417     1.491     2.859     2.461     1.740    86.503        4.023
V242NYCC      .288      .719      .863     3.309     2.878     2.158     1.727     1.727    86.331         .645
V242NYCC      .638     1.913     2.551     2.551     2.806     2.551     3.189     3.827    79.974         .784
V242IDLE     0.000     0.000     0.000      .196      .391      .293      .391     4.692    94.037        1.023
V242IDLE     3.282     4.048     3.720     1.422      .875     1.313     1.969     1.860    81.510         .914
V24250KH     0.000     0.000     0.000      .228      .571     1.598     1.142     3.995    92.466         .876
V24285KH      .029      .292      .438      .511      .656     1.896     2.261     2.640    91.276        6.855
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AVERAGE PERCENT OF EXHAUST PARTICULATE
COLLECTED BY ANDERSON IMPACTOR BY STAGES
FROM A MERCEDES 240D AND A VW RABBIT (DIESEL)

BY VEHICLE

TEST TYPE	STAGE 1	STAGE 2	STAGE 3	STAGE 4	STAGE 5	STAGE 6	STAGE 7	STAGE 8	STAGE 9	TOTAL PARTICULATE
M238FTPC	.704	.241	2.762	2.354	2.929	3.800	3.577	3.707	79.926	5.395
M238FTPM	.547	.538	1.256	2.545	2.171	2.835	3.185	3.819	83.103	4.820
M238CFDS	.434	.770	1.468	1.611	2.909	3.415	4.054	3.828	81.511	6.169
M238FET	.153	.524	1.603	2.103	1.830	2.837	3.465	4.366	83.119	5.126
M238NYCC	1.474	1.934	3.138	3.796	3.657	4.607	4.061	1.587	75.745	1.549
M238IDLE	2.584	1.034	0.000	.431	2.153	1.723	2.584	3.015	86.477	1.161
M23850KM	.615	.707	.615	.769	1.383	1.691	2.306	2.920	86.995	3.253
M23885KM	.166	.217	.447	.447	1.291	2.237	3.771	3.618	87.805	7.823
M239FTPC	.410	.859	2.329	1.992	2.418	3.826	3.862	3.814	80.491	5.402
M239FTPM	.484	.608	1.396	1.578	1.880	2.717	3.124	3.707	84.507	5.274
M239CFDS	.187	.376	.737	1.437	2.155	3.187	3.755	4.027	84.139	7.080
M239FET	.148	.211	.781	.992	1.351	2.723	3.040	3.673	87.080	4.737
M239NYCC	.285	.142	.570	1.425	1.638	1.852	3.917	3.561	86.610	1.404
M239IDLE	.216	.288	.935	.791	.647	1.583	1.655	2.518	91.367	1.390
M23950KM	.547	.486	.456	.486	.912	1.003	2.279	2.522	91.310	3.291
M23985KM	.716	.351	.506	.955	1.461	2.459	3.386	3.512	86.654	7.118
M240FTPC	.191	.637	2.431	2.106	2.121	3.632	2.864	3.096	82.920	4.414
M240FTPM	.117	.719	1.609	1.542	1.905	2.607	2.476	3.148	85.878	3.972
M240CFDS	.150	.587	1.476	1.832	2.256	3.765	3.476	3.728	82.729	5.518
M240FET	.026	.132	.924	.818	1.188	2.376	2.904	3.247	88.384	3.788
M240NYCC	.229	.801	1.144	1.716	2.288	2.860	2.860	4.577	83.524	.874
M240IDLE	.939	1.761	2.347	3.286	3.169	2.465	4.343	3.286	78.404	.852
M24050KM	.257	.623	.260	.246	1.268	1.879	2.216	2.563	90.688	2.670
M24085KM	.097	.697	.600	.568	1.379	1.768	2.303	3.228	89.359	6.165
M241FTPC	.461	.814	2.375	2.449	2.531	3.903	4.164	4.361	78.942	5.934
M241FTPM	.488	.631	1.253	1.650	1.885	2.931	3.672	4.115	83.375	5.902
M241CFDS	.186	.513	1.966	2.128	2.888	4.164	4.676	4.881	78.599	8.400
M241FET	.131	.766	2.294	.809	2.522	2.889	3.364	3.798	83.426	5.667
M241NYCC	1.408	1.199	3.076	3.754	2.503	4.484	3.441	4.275	75.860	1.918
M241IDLE	2.445	1.246	.719	1.198	2.205	2.061	2.253	3.787	84.084	2.086
M24150KM	.561	1.096	1.444	1.203	1.845	2.620	2.941	3.449	84.840	3.740
M24185KM	.447	.671	.871	.857	.750	2.462	3.219	4.053	86.670	9.267
M242FTPC	.538	.939	3.137	3.071	3.310	3.777	3.528	3.733	77.968	4.892
M242FTPM	.412	.740	2.052	2.001	2.297	2.801	2.889	3.416	83.391	4.444
M242CFDS	.265	.603	2.419	2.321	2.496	4.155	3.961	4.596	79.124	6.708
M242FET	.114	.182	1.249	1.499	1.840	2.839	3.611	3.725	84.942	4.403
M242NYCC	1.231	1.642	2.394	2.736	2.668	4.241	2.668	3.078	79.343	1.462
M242IDLE	.579	1.937	.821	.881	1.465	3.941	5.718	7.726	76.932	.822
M24250KM	.363	.634	.627	.611	.701	1.453	2.257	2.713	90.640	2.781
M24285KM	.049	.210	.618	.741	.717	2.064	4.041	3.497	88.064	8.053
AVER.	.534	.728	1.428	1.593	1.975	2.866	3.297	3.657	83.923	4.394
VMAX.	2.584	1.937	3.138	3.796	3.657	4.607	5.718	7.726	91.367	9.267
VMIN.	.026	.132	0.000	.246	.647	1.003	1.655	1.587	75.745	.822
S.D.	.574	.463	.871	.920	.750	.922	.799	.924	4.342	2.300
RANGE	2.558	1.805	3.138	3.551	3.010	3.604	4.064	6.140	15.622	8.445
VARI.	107.488	63.613	61.026	57.739	37.988	32.171	24.249	25.261	5.174	52.335

AVERAGE PERCENT OF EXHAUST PARTICULATE
COLLECTED BY ANDERSON IMPACTOR BY STAGES
FROM A MERCEDES 240D AND A VW RABBIT (DIESEL)

BY VEHICLE

TEST TYPE	STAGE 1	STAGE 2	STAGE 3	STAGE 4	STAGE 5	STAGE 6	STAGE 7	STAGE 8	STAGE 9	TOTAL PARTICULATE
V238FTPC	.665	1.001	3.368	3.530	3.530	4.924	4.348	3.552	75.081	3.879
V238FTPH	1.547	1.808	3.685	2.901	4.541	4.819	4.136	4.883	71.681	2.830
V238CFDS	.948	1.221	3.414	3.310	3.553	5.435	5.252	3.979	72.889	6.525
V238FET	.862	.412	5.208	1.424	2.435	2.435	3.972	2.435	80.817	2.669
V238NYCC	1.195	2.151	4.062	2.987	2.270	6.571	4.301	5.376	71.087	.837
V23850KH	1.554	.104	.466	.207	.621	1.243	1.554	1.295	92.957	1.931
V239FTPC	.911	1.771	3.688	3.568	3.704	5.307	4.626	3.939	72.487	4.080
V239FTPH	.545	.859	2.050	2.024	2.639	4.142	2.975	2.811	81.954	3.148
V239CFDS	.726	1.072	2.580	2.819	3.603	4.264	4.420	3.764	76.753	6.013
V239FET	.599	.180	1.228	1.018	1.497	1.946	1.467	1.946	90.120	3.340
V239NYCC	.302	2.920	1.511	3.021	5.740	4.632	4.632	2.820	74.421	.993
V239IDLE	.204	.716	.350	.394	1.296	.934	1.226	1.678	93.202	1.000
V23950KH	1.483	1.922	.824	1.318	1.043	1.757	1.208	2.526	87.919	1.821
V23985KH	.407	.407	.678	.753	1.130	2.259	2.410	2.711	89.245	6.639
V240FTPC	.591	1.530	3.540	3.538	3.646	5.027	3.411	2.766	75.950	3.401
V240FTPH	.206	.518	2.172	1.658	2.232	3.392	2.133	1.682	86.007	2.582
V240CFDS	.568	1.124	3.533	3.406	3.653	5.256	3.391	3.085	75.984	5.027
V240FET	1.148	1.037	1.834	1.356	1.468	2.011	1.659	1.818	87.668	3.134
V240NYCC	2.601	3.785	4.549	3.620	5.483	5.381	2.492	3.903	68.186	.652
V240IDLE	.552	5.525	1.105	2.762	2.486	.552	2.486	2.762	81.768	.362
V24050KH	.148	0.000	.148	.296	.370	.665	1.330	2.217	94.826	1.353
V24085KH	.151	.108	.710	.473	.989	.925	1.527	1.613	93.504	4.649
V241FTPC	.481	1.585	2.169	1.823	2.492	3.261	3.241	8.079	76.869	8.506
V241FTPH	.713	1.005	2.616	2.950	2.737	3.360	2.385	2.369	81.866	3.871
V241CFDS	.695	1.004	2.602	2.000	2.294	3.129	3.037	3.593	81.645	6.471
V241FET	.492	.246	.763	1.231	1.649	2.757	2.462	3.053	87.346	4.062
V241NYCC	1.385	1.622	5.585	3.974	1.322	1.518	1.620	1.545	81.430	1.250
V241IDLE	1.574	.762	1.195	3.502	.439	.650	.111	.514	91.253	1.819
V24150KH	.303	.204	.386	.292	.083	.317	.599	3.578	94.236	12.868
V24185KH	.189	.325	.755	.625	.924	1.718	2.727	4.210	88.527	7.683
V242FTPC	.667	1.876	3.060	3.120	3.844	4.805	3.871	3.509	75.247	3.268
V242FTPH	.769	1.406	2.272	2.462	2.982	4.797	3.109	2.933	79.269	2.756
V242CFDS	.062	1.143	2.203	1.247	1.538	2.390	2.453	2.245	86.718	4.811
V242FET	.416	.627	1.634	1.335	1.572	2.882	2.355	2.365	86.814	3.767
V242NYCC	.463	1.316	1.707	2.930	2.842	2.355	2.458	2.777	83.153	.739
V242IDLE	1.641	2.024	1.860	.809	.633	.803	1.180	3.276	87.773	.968
V24250KH	0.000	0.000	0.000	.228	.571	1.598	1.142	3.995	92.466	.876
V24285KH	.029	.292	.438	.511	.656	1.896	2.261	2.640	91.276	6.855
AVER.	.731	1.200	2.104	1.985	2.224	2.950	2.631	3.006	83.168	3.617
VMAX.	2.601	5.525	5.585	3.974	5.740	6.571	5.252	8.079	94.826	12.868
VMIN.	0.000	0.000	0.000	.207	.083	.317	.111	.514	68.186	.362
S.D.	.564	1.099	1.453	1.220	1.428	1.734	1.256	1.316	7.625	2.655
RANGE	2.601	5.525	5.585	3.767	5.657	6.254	5.141	7.565	26.640	12.506
VARI.	77.084	91.532	69.067	61.447	64.229	58.771	47.742	43.785	9.168	73.398

AVERAGE PERCENT OF EXHAUST PARTICULATE
COLLECTED BY ANDERSON IMPACTOR BY STAGES
FROM A MERCEDES 240D AND A VW RABBIT (DIESEL)

BY FUEL

TEST TYPE	STAGE 1	STAGE 2	STAGE 3	STAGE 4	STAGE 5	STAGE 6	STAGE 7	STAGE 8	STAGE 9	TOTAL PARTICULATE
M238FTPC	.704	.241	2.762	2.354	2.929	3.800	3.577	3.707	79.926	5.395
M238FTPH	.547	.538	1.256	2.545	2.171	2.835	3.185	3.819	83.103	4.820
M238CFDS	.434	.770	1.468	1.611	2.909	3.415	4.054	3.828	81.511	6.169
M238FET	.153	.524	1.603	2.103	1.830	2.837	3.465	4.366	83.119	5.126
M238NYCC	1.474	1.934	3.138	3.796	3.657	4.607	4.061	1.587	75.745	1.549
M238IDLE	2.584	1.034	0.000	.431	2.153	1.723	2.594	3.015	86.477	1.161
M23850KH	.615	.707	.615	.769	1.383	1.691	2.306	2.920	88.995	3.253
M23885KH	.166	.217	.447	.447	1.291	2.237	3.771	3.618	87.805	7.823
V238FTPC	.665	1.001	3.368	3.530	3.530	4.924	4.348	3.552	75.081	3.879
V238FTPH	1.547	1.808	3.685	2.901	4.541	4.819	4.136	4.883	71.681	2.830
V238CFDS	.948	1.221	3.414	3.310	3.553	5.435	5.252	3.979	72.889	6.525
V238FET	.862	.412	5.208	1.424	2.435	2.435	3.972	2.435	80.817	2.669
V238NYCC	1.195	2.151	4.062	2.987	2.270	6.571	4.301	5.376	71.087	.837
V23850KH	1.554	.104	.466	.207	.621	1.243	1.554	1.295	92.957	1.931
AVER.	.961	.904	2.243	2.030	2.520	3.469	3.612	3.456	80.800	3.855
VMAX.	2.584	2.151	5.208	3.796	4.541	6.571	5.252	5.376	92.957	7.823
VMIN.	.153	.104	0.000	.207	.621	1.243	1.554	1.295	71.087	.837
S.D.	.660	.662	1.616	1.227	1.074	1.603	.950	1.140	6.831	2.172
RANGE	2.431	2.047	5.208	3.589	3.919	5.328	3.698	4.082	21.870	6.986
VARI.	68.718	73.140	71.825	60.466	42.620	46.193	26.308	32.978	8.454	56.355

AVERAGE PERCENT OF EXHAUST PARTICULATE
COLLECTED BY ANDERSON IMPACTOR BY STAGES
FROM A MERCEDES 240D AND A VW RABBIT (DIESEL)

BY FUEL

TEST TYPE	STAGE 1	STAGE 2	STAGE 3	STAGE 4	STAGE 5	STAGE 6	STAGE 7	STAGE 8	STAGE 9	TOTAL PARTICULATE
M239FTPC	.410	.859	2.329	1.992	2.418	3.826	3.862	3.814	80.491	5.402
M239FTPH	.484	.608	1.396	1.578	1.880	2.717	3.124	3.707	84.507	5.274
M239CFDS	.187	.376	.737	1.437	2.155	3.187	3.755	4.027	84.139	7.080
M239FET	.148	.211	.781	.992	1.351	2.723	3.040	3.673	87.080	4.737
M239NYCC	.285	.142	.570	1.425	1.638	1.852	3.917	3.561	86.610	1.404
M239IDLE	.216	.288	.935	.791	.647	1.583	1.655	2.518	91.367	1.390
M23950KH	.547	.486	.456	.486	.912	1.003	2.279	2.522	91.310	3.291
M23985KH	.716	.351	.506	.955	1.461	2.459	3.386	3.512	86.654	7.118
V239FTPC	.911	1.771	3.688	3.568	3.704	5.307	4.626	3.939	72.487	4.080
V239FTPH	.545	.859	2.050	2.024	2.639	4.142	2.975	2.811	81.954	3.148
V239CFDS	.726	1.072	2.580	2.819	3.603	4.264	4.420	3.764	76.753	6.013
V239FET	.599	.180	1.228	1.018	1.497	1.946	1.467	1.946	90.120	3.340
V239NYCC	.302	2.920	1.511	3.021	5.740	4.632	4.632	2.820	74.421	.993
V239IDLE	.204	.716	.350	.394	1.296	.934	1.226	1.678	93.202	1.000
V23950KH	1.483	1.922	.824	1.318	1.093	1.757	1.208	2.526	87.919	1.821
V23985KH	.407	.407	.678	.753	1.130	2.259	2.410	2.711	89.245	6.639
AVER.	.511	.823	1.288	1.536	2.070	2.787	2.949	3.096	84.891	3.921
VMAX.	1.483	2.920	3.688	3.568	5.740	5.307	4.632	4.027	93.202	7.118
VMIN.	.148	.142	.350	.394	.647	.934	1.208	1.678	72.487	.993
S.D.	.340	.769	.936	.930	1.324	1.320	1.184	.742	6.202	2.195
RANGE	1.335	2.779	3.338	3.174	5.093	4.373	3.424	2.349	20.715	6.125
VARI.	66.644	93.456	72.611	60.560	63.957	47.348	39.483	23.972	7.306	55.984

AVERAGE PERCENT OF EXHAUST PARTICULATE
COLLECTED BY ANDERSON IMPACTOR BY STAGES
FROM A MERCEDES 240D AND A VW RABBIT (DIESEL)

BY FUEL

TEST TYPE	STAGE 1	STAGE 2	STAGE 3	STAGE 4	STAGE 5	STAGE 6	STAGE 7	STAGE 8	STAGE 9	TOTAL PARTICULATE
M240FTPC	.191	.637	2.431	2.106	2.121	3.632	2.864	3.096	82.920	4.414
M240FTPH	.117	.719	1.609	1.542	1.905	2.607	2.476	3.148	85.878	3.972
M240CFDS	.150	.587	1.476	1.832	2.256	3.765	3.476	3.728	82.729	5.518
M240FET	.026	.132	.924	.818	1.188	2.376	2.904	3.247	88.384	3.788
M240NYCC	.229	.801	1.144	1.716	2.288	2.860	2.860	4.577	83.524	.874
M240IDLE	.939	1.761	2.347	3.286	3.169	2.465	4.343	3.286	78.404	.852
M24050KM	.257	.623	.260	.246	1.268	1.879	2.216	2.563	90.688	2.670
M24085KM	.097	.697	.600	.568	1.379	1.768	2.303	3.228	89.359	6.165
V240FTPC	.591	1.530	3.540	3.538	3.646	5.027	3.411	2.766	75.950	3.401
V240FTPH	.206	.518	2.172	1.658	2.232	3.392	2.133	1.682	86.007	2.582
V240CFDS	.568	1.124	3.533	3.406	3.653	5.256	3.391	3.085	75.984	5.027
V240FET	1.148	1.037	1.834	1.356	1.468	2.011	1.659	1.818	87.668	3.134
V240NYCC	2.601	3.785	4.549	3.620	5.483	5.381	2.492	3.903	68.186	.652
V240IDLE	.552	5.525	1.105	2.762	2.486	.552	2.486	2.762	81.768	.362
V24050KM	.148	0.000	.148	.296	.370	.665	1.330	2.217	94.826	1.353
V24085KM	.151	.108	.710	.473	.989	.925	1.527	1.613	93.504	4.649
AVER.	.498	1.224	1.774	1.827	2.244	2.785	2.617	2.920	84.111	3.088
VMAX.	2.601	5.525	4.549	3.620	5.483	5.381	4.343	4.577	94.826	6.165
VMIN.	.026	0.000	.148	.246	.370	.552	1.330	1.613	68.186	.362
S.D.	.646	1.455	1.264	1.193	1.265	1.541	.794	.814	7.021	1.851
RANGE	2.574	5.525	4.401	3.374	5.114	4.829	3.012	2.963	26.640	5.803
VARI.	129.619	118.843	71.252	65.310	56.368	55.331	30.334	27.872	8.348	59.944

AVERAGE PERCENT OF EXHAUST PARTICULATE
COLLECTED BY ANDERSON IMPACTOR BY STAGES
FROM A MERCEDES 240D AND A VW RABBIT (DIESEL)

BY FUEL

TEST TYPE	STAGE 1	STAGE 2	STAGE 3	STAGE 4	STAGE 5	STAGE 6	STAGE 7	STAGE 8	STAGE 9	TOTAL PARTICULATE
M241FTPC	.461	.814	2.375	2.449	2.531	3.903	4.164	4.361	78.942	5.934
M241FTPH	.488	.631	1.253	1.650	1.885	2.931	3.672	4.115	83.375	5.902
M241CFDS	.186	.513	1.966	2.128	2.888	4.164	4.676	4.881	78.599	8.400
M241FET	.131	.766	2.294	.809	2.522	2.889	3.364	3.798	83.426	5.667
M241NYCC	1.408	1.199	3.076	3.754	2.503	4.484	3.441	4.275	75.860	1.918
M241IDLE	2.445	1.246	.719	1.198	2.205	2.061	2.253	3.787	84.084	2.086
M24150KM	.561	1.096	1.444	1.203	1.845	2.620	2.941	3.449	84.840	3.740
M24185KM	.447	.671	.871	.857	.750	2.462	3.219	4.053	86.670	9.267
V241FTPC	.481	1.585	2.169	1.823	2.492	3.261	3.241	8.079	76.869	8.506
V241FTPH	.713	1.005	2.616	2.950	2.737	3.360	2.385	2.369	81.866	3.871
V241CFDS	.695	1.004	2.602	2.000	2.294	3.129	3.037	3.593	81.645	6.471
V241FET	.492	.246	.763	1.231	1.649	2.757	2.462	3.053	87.346	4.062
V241NYCC	1.385	1.622	5.585	3.974	1.322	1.518	1.620	1.545	81.430	1.250
V241IDLE	1.574	.762	1.195	3.502	.439	.650	.111	.514	91.253	1.819
V24150KM	.303	.204	.386	.292	.083	.317	.599	3.578	94.236	12.868
V24185KM	.189	.325	.755	.625	.924	1.718	2.727	4.210	88.527	7.683
AVER.	.747	.856	1.879	1.903	1.817	2.639	2.744	3.729	83.686	5.591
VMAX.	2.445	1.622	5.585	3.974	2.888	4.484	4.676	8.079	94.236	12.868
VMIN.	.131	.204	.386	.292	.083	.317	.111	.514	75.860	1.250
S.D.	.634	.431	1.288	1.147	.873	1.168	1.192	1.612	5.064	3.223
RANGE	2.313	1.418	5.199	3.681	2.805	4.166	4.565	7.565	18.376	11.618
VARI.	84.791	50.401	68.545	60.301	48.032	44.248	43.446	43.229	6.051	57.651

AVERAGE PERCENT OF EXHAUST PARTICULATE COLLECTED BY ANDERSON IMPACTOR BY STAGES FROM A MERCEDES 240D AND A VW RABRIT (DIESEL)

BY FUEL

TEST TYPE	STAGE 1	STAGE 2	STAGE 3	STAGE 4	STAGE 5	STAGE 6	STAGE 7	STAGE 8	STAGE 9	TOTAL PARTICULATE
M242FTPC	.538	.939	3.137	3.071	3.310	3.777	3.528	3.733	77.968	4.892
M242FTPH	.412	.740	2.052	2.001	2.297	2.801	2.889	3.416	83.391	4.444
M242CFDS	.265	.663	2.419	2.321	2.496	4.155	3.961	4.596	79.124	6.70[illegible]
M242FET	.114	.182	1.249	1.499	1.840	2.839	3.611	3.725	84.942	4.403
M242NYCC	1.231	1.642	2.394	2.736	2.668	4.241	2.668	3.078	79.343	1.462
M242IDLE	.579	1.937	.821	.881	1.465	3.941	5.718	7.726	76.932	.822
M24250KH	.363	.634	.627	.611	.701	1.453	2.257	2.713	90.640	2.781
M24285KH	.049	.210	.618	.741	.717	2.064	4.041	3.497	88.064	8.093
V242FTPC	.667	1.876	3.060	3.120	3.844	4.805	3.871	3.509	75.247	3.268
V242FTPH	.769	1.406	2.272	2.462	2.982	4.797	3.109	2.933	79.269	2.756
V242CFDS	.062	1.143	2.203	1.247	1.538	2.390	2.453	2.245	86.718	4.811
V242FFT	.416	.627	1.634	1.335	1.572	2.882	2.355	2.365	86.814	3.767
V242NYCC	.463	1.316	1.707	2.930	2.842	2.355	2.458	2.777	83.153	.739
V242IDLE	1.641	2.024	1.860	.809	.633	.803	1.180	3.276	87.773	.968
V24250KH	0.000	0.000	0.000	.228	.571	1.598	1.142	3.995	92.466	.876
V24285KH	.029	.292	.438	.511	.656	1.896	2.261	2.640	91.276	6.855
AVER.	.475	.977	1.656	1.656	1.883	2.925	2.969	3.514	83.945	3.603
VMAX.	1.641	2.024	3.137	3.120	3.844	4.805	5.718	7.726	92.466	8.093
VMIN.	0.000	0.000	0.000	.228	.571	.803	1.142	2.245	75.247	.739
S.D.	.450	.665	.945	1.001	1.068	1.236	1.149	1.283	5.462	2.328
RANGE	1.641	2.024	3.137	2.891	3.274	4.002	4.577	5.481	17.219	7.353
VARI.	94.797	68.086	57.084	60.446	56.713	42.250	38.697	36.524	6.507	64.605

AVERAGE PERCENT OF EXHAUST PARTICULATE COLLECTED BY ANDERSON IMPACTOR BY STAGES FROM A MERCEDES 240D AND A VW RABBIT (DIESEL)

BY TEST PROCEDURE

TEST TYPE	STAGE 1	STAGE 2	STAGE 3	STAGE 4	STAGE 5	STAGE 6	STAGE 7	STAGE 8	STAGE 9	TOTAL PARTICULATE
M238FTPC	.704	.241	2.762	2.354	2.929	3.800	3.577	3.707	79.926	5.395
M239FTPC	.410	.859	2.329	1.992	2.418	3.826	3.862	3.814	80.491	5.402
M240FTPC	.191	.637	2.431	2.106	2.121	3.632	2.864	3.096	82.920	4.414
M241FTPC	.461	.814	2.375	2.449	2.531	3.903	4.164	4.361	78.942	5.934
M242FTPC	.538	.939	3.137	3.071	3.310	3.777	3.528	3.733	77.968	4.892
V238FTPC	.665	1.001	3.368	3.530	3.530	4.924	4.348	3.552	75.081	3.879
V239FTPC	.911	1.771	3.688	3.568	3.704	5.307	4.626	3.939	72.487	4.080
V240FTPC	.591	1.530	3.540	3.538	3.646	5.027	3.411	2.766	75.950	3.401
V241FTPC	.481	1.585	2.169	1.823	2.492	3.261	3.241	8.079	76.869	8.506
V242FTPC	.667	1.876	3.060	3.120	3.844	4.805	3.871	3.509	75.247	3.268
AVER.	.562	1.125	2.886	2.755	3.052	4.226	3.749	4.056	77.588	4.917
VMAX.	.911	1.876	3.688	3.568	3.844	5.307	4.626	8.079	82.920	8.506
VMIN.	.191	.241	2.169	1.823	2.121	3.261	2.864	2.766	72.487	3.268
S.D.	.195	.537	.548	.686	.630	.712	.533	1.480	3.078	1.543
RANGE	.719	1.635	1.519	1.745	1.724	2.046	1.761	5.313	10.433	5.238
VARI.	34.692	47.706	18.992	24.897	20.635	16.852	14.225	36.494	3.968	31.381

AVERAGE PERCENT OF EXHAUST PARTICULATE
COLLECTED BY ANDERSON IMPACTOR BY STAGES
FROM A MERCEDES 240D AND A VW RABBIT (DIESEL)

BY TEST PROCEDURE

TEST TYPE	STAGE 1	STAGE 2	STAGE 3	STAGE 4	STAGE 5	STAGE 6	STAGE 7	STAGE 8	STAGE 9	TOTAL PARTICULATE
M238FTPH	.547	.538	1.256	2.545	2.171	2.835	3.185	3.819	83.103	4.820
M239FTPH	.484	.608	1.396	1.578	1.880	2.717	3.124	3.707	84.507	5.274
M240FTPH	.117	.719	1.609	1.542	1.905	2.607	2.476	3.148	85.878	3.972
M241FTPH	.488	.631	1.253	1.650	1.885	2.931	3.672	4.115	83.375	5.902
M242FTPH	.412	.740	2.052	2.001	2.297	2.801	2.889	3.416	83.391	4.444
V238FTPH	1.547	1.808	3.685	2.901	4.541	4.819	4.136	4.883	71.681	2.830
V239FTPH	.545	.859	2.050	2.024	2.639	4.142	2.975	2.911	81.954	3.148
V240FTPH	.206	.518	2.172	1.658	2.232	3.392	2.133	1.682	86.007	2.582
V241FTPH	.713	1.005	2.616	2.950	2.737	3.360	2.385	2.369	81.866	3.871
V242FTPH	.769	1.406	2.272	2.462	2.982	4.797	3.109	2.933	79.269	2.756
AVER.	.583	.883	2.036	2.131	2.527	3.440	3.008	3.288	82.103	3.960
VMAX.	1.547	1.808	3.685	2.950	4.541	4.819	4.136	4.883	86.007	5.902
VMIN.	.117	.518	1.253	1.542	1.880	2.607	2.133	1.682	71.681	2.582
S.D.	.393	.419	.741	.546	.803	.850	.598	.913	4.167	1.143
RANGE	1.429	1.290	2.431	1.408	2.661	2.212	2.003	3.201	14.326	3.320
VARI.	67.426	47.491	36.398	25.611	31.777	24.697	19.884	27.757	5.075	28.871

AVERAGE PERCENT OF EXHAUST PARTICULATE
COLLECTED BY ANDERSON IMPACTOR BY STAGES
FROM A MERCEDES 240D AND A VW RABBIT (DIESEL)

BY TEST PROCEDURE

TEST TYPE	STAGE 1	STAGE 2	STAGE 3	STAGE 4	STAGE 5	STAGE 6	STAGE 7	STAGE 8	STAGE 9	TOTAL PARTICULATE
M238CFDS	.434	.770	1.468	1.611	2.909	3.415	4.054	3.828	81.511	6.169
M239CFDS	.187	.376	.737	1.437	2.155	3.187	3.755	4.027	84.139	7.080
M240CFDS	.150	.587	1.476	1.832	2.256	3.765	3.476	3.728	82.729	5.518
M241CFDS	.186	.513	1.966	2.128	2.888	4.164	4.676	4.881	78.599	8.400
M242CFDS	.265	.663	2.419	2.321	2.496	4.155	3.961	4.596	79.124	6.708
V238CFDS	.948	1.221	3.414	3.310	3.553	5.435	5.252	3.979	72.889	6.525
V239CFDS	.726	1.072	2.580	2.819	3.603	4.264	4.420	3.764	76.753	6.013
V240CFDS	.568	1.124	3.533	3.406	3.653	5.256	3.391	3.085	75.984	5.027
V241CFDS	.695	1.004	2.602	2.000	2.294	3.129	3.037	3.593	81.645	6.471
V242CFDS	.062	1.143	2.203	1.247	1.538	2.390	2.453	2.245	86.718	4.811
AVER.	.422	.847	2.240	2.211	2.735	3.916	3.847	3.773	80.009	6.272
VMAX.	.948	1.221	3.533	3.406	3.653	5.435	5.252	4.881	86.718	8.400
VMIN.	.062	.376	.737	1.247	1.538	2.390	2.453	2.245	72.889	4.811
S.D.	.299	.302	.872	.753	.712	.948	.816	.735	4.145	1.044
RANGE	.885	.845	2.796	2.159	2.115	3.045	2.799	2.636	13.829	3.589
VARI.	70.794	35.631	38.929	34.050	26.051	24.219	21.223	19.474	5.181	16.644

AVERAGE PERCENT OF EXHAUST PARTICULATE
COLLECTED BY ANDERSON IMPACTOR BY STAGES
FROM A MERCEDES 240D AND A VW RABBIT (DIESEL)

BY TEST PROCEDURE

TEST TYPE	STAGE 1	STAGE 2	STAGE 3	STAGE 4	STAGE 5	STAGE 6	STAGE 7	STAGE 8	STAGE 9	TOTAL PARTICULATE
M238FFET	.153	.524	1.603	2.103	1.830	2.837	3.465	4.366	83.119	5.126
M239FFET	.148	.211	.781	.992	1.351	2.723	3.040	3.673	87.080	4.737
M240FFET	.026	.132	.924	.818	1.188	2.376	2.904	3.247	88.384	3.788
M241FFET	.131	.766	2.294	.809	2.522	2.889	3.364	3.798	83.426	5.667
M242FFET	.114	.182	1.249	1.499	1.840	2.839	3.611	3.725	84.942	4.403
V238FFET	.862	.412	5.208	1.424	2.435	2.435	3.972	2.435	80.817	2.669
V239FFET	.599	.180	1.228	1.018	1.497	1.946	1.467	1.946	90.120	3.340
V240FFET	1.148	1.037	1.834	1.356	1.468	2.011	1.659	1.818	87.668	3.134
V241FFET	.492	.246	.763	1.231	1.649	2.757	2.462	3.053	87.346	4.062
V242FFET	.416	.627	1.634	1.335	1.572	2.882	2.355	2.365	86.814	3.767
AVER.	.409	.432	1.752	1.259	1.735	2.570	2.830	3.043	85.972	4.069
VMAX.	1.148	1.037	5.208	2.103	2.522	2.889	3.972	4.366	90.120	5.667
VMIN.	.026	.132	.763	.809	1.188	1.946	1.467	1.818	80.817	2.669
S.D.	.371	.303	1.309	.386	.440	.359	.833	.866	2.828	.929
RANGE	1.121	.905	4.445	1.293	1.334	.943	2.504	2.548	9.303	2.998
VARI.	90.715	70.091	74.710	30.637	25.328	13.963	29.424	28.476	3.290	22.825

AVERAGE PERCENT OF EXHAUST PARTICULATE
COLLECTED BY ANDERSON IMPACTOR BY STAGES
FROM A MERCEDES 240D AND A VW RABBIT (DIESEL)

BY TEST PROCEDURE

TEST TYPE	STAGE 1	STAGE 2	STAGE 3	STAGE 4	STAGE 5	STAGE 6	STAGE 7	STAGE 8	STAGE 9	TOTAL PARTICULATE
M238NYCC	1.474	1.934	3.138	3.796	3.657	4.607	4.061	1.587	75.745	1.549
M239NYCC	.285	.142	.570	1.425	1.638	1.852	3.917	3.561	86.610	1.404
M240NYCC	.229	.801	1.144	1.716	2.288	2.860	2.860	4.577	83.524	.874
M241NYCC	1.408	1.199	3.076	3.754	2.503	4.484	3.441	4.275	75.860	1.918
M242NYCC	1.231	1.642	2.394	2.736	2.668	4.241	2.668	3.078	79.343	1.462
V238NYCC	1.195	2.151	4.062	2.987	2.270	6.571	4.301	5.376	71.087	.837
V239NYCC	.302	2.920	1.511	3.021	5.740	4.632	4.632	2.820	74.421	.993
V240NYCC	2.601	3.785	4.549	3.620	5.483	5.381	2.492	3.903	68.186	.652
V241NYCC	1.385	1.622	5.585	3.974	1.322	1.518	1.620	1.545	81.430	1.250
V242NYCC	.463	1.316	1.707	2.930	2.842	2.355	2.458	2.777	83.153	.739
AVER.	1.057	1.751	2.774	2.996	3.041	3.850	3.245	3.350	77.936	1.168
VMAX.	2.601	3.785	5.585	3.974	5.740	6.571	4.632	5.376	86.610	1.918
VMIN.	.229	.142	.570	1.425	1.322	1.518	1.620	1.545	68.186	.652
S.D.	.748	1.039	1.610	.865	1.497	1.638	.972	1.241	5.881	.413
RANGE	2.372	3.643	5.015	2.549	4.418	5.053	3.013	3.832	18.424	1.266
VARI.	70.795	59.314	58.047	28.887	49.241	42.535	29.961	37.059	7.546	35.343

AVERAGE PERCENT OF EXHAUST PARTICULATE
COLLECTED BY ANDERSON IMPACTOR BY STAGES
FROM A MERCEDES 240D AND A VW RABBIT (DIESEL)

BY TEST PROCEDURE

TEST TYPE	STAGE 1	STAGE 2	STAGE 3	STAGE 4	STAGE 5	STAGE 6	STAGE 7	STAGE 8	STAGE 9	TOTAL PARTICULATE
M238IDLE	2.584	1.034	0.000	.431	2.153	1.723	2.584	3.015	86.477	1.161
M239IDLE	.216	.288	.935	.791	.647	1.583	1.655	2.518	91.367	1.390
M240IDLE	.939	1.761	2.347	3.286	3.169	2.465	4.343	3.286	78.404	.852
M241IDLE	2.445	1.246	.719	1.198	2.205	2.061	2.253	3.787	84.084	2.086
M242IDLE	.579	1.937	.821	.881	1.465	3.941	5.718	7.726	76.932	.822
V239IDLE	.204	.716	.350	.394	1.296	.934	1.226	1.679	93.202	1.000
V240IDLE	.552	5.525	1.105	2.762	2.486	.552	2.486	2.762	81.768	.362
V241IDLE	1.574	.762	1.195	3.502	.439	.650	.111	.514	91.253	1.819
V242IDLE	1.641	2.024	1.860	.809	.633	.803	1.180	3.276	87.773	.968
AVER.	1.193	1.699	1.037	1.562	1.611	1.635	2.395	3.174	85.696	1.162
VMAX.	2.584	5.525	2.347	3.502	3.169	3.941	5.718	7.726	93.202	2.086
VMIN.	.204	.288	0.000	.394	.439	.552	.111	.514	76.932	.362
S.D.	.911	1.553	.718	1.254	.950	1.091	1.714	1.970	5.834	.531
RANGE	2.380	5.237	2.347	3.108	2.730	3.388	5.608	7.212	16.270	1.724
VARI.	76.343	91.379	69.288	80.303	58.981	66.745	71.573	62.087	6.808	45.658

AVERAGE PERCENT OF EXHAUST PARTICULATE
COLLECTED BY ANDERSON IMPACTOR BY STAGES
FROM A MERCEDES 240D AND A VW RABRIT (DIESEL)

BY TEST PROCEDURE

TEST TYPE	STAGE 1	STAGE 2	STAGE 3	STAGE 4	STAGE 5	STAGE 6	STAGE 7	STAGE 8	STAGE 9	TOTAL PARTICULATE
M23850KM	.615	.707	.615	.769	1.383	1.691	2.306	2.920	88.995	3.253
M23950KM	.547	.486	.456	.486	.912	1.003	2.279	2.522	91.310	3.291
M24050KM	.257	.623	.260	.246	1.268	1.879	2.216	2.563	90.688	2.670
M24150KM	.561	1.096	1.444	1.203	1.845	2.620	2.941	3.449	84.840	3.740
M24250KM	.363	.634	.627	.611	.701	1.453	2.257	2.713	90.640	2.781
V23850KM	1.554	.104	.466	.207	.621	1.243	1.554	1.295	92.957	1.931
V23950KM	1.483	1.922	.824	1.318	1.043	1.757	1.208	2.526	87.919	1.821
V24050KM	.148	0.000	.148	.296	.370	.665	1.330	2.217	94.826	1.353
V24150KM	.303	.204	.386	.292	.083	.317	.599	3.578	94.236	12.868
V24250KM	0.000	0.000	0.000	.228	.571	1.598	1.142	3.995	92.466	.876
AVER.	.583	.578	.522	.566	.880	1.423	1.783	2.778	90.888	3.458
VMAX.	1.554	1.922	1.444	1.318	1.845	2.620	2.941	3.995	94.826	12.868
VMIN.	0.000	0.000	0.000	.207	.083	.317	.599	1.295	84.840	.876
S.D.	.529	.590	.404	.410	.522	.655	.721	.767	3.032	3.430
RANGE	1.554	1.922	1.444	1.111	1.762	2.303	2.342	2.701	9.987	11.992
VARI.	90.689	102.221	77.289	72.518	59.342	46.045	40.414	27.593	3.336	99.181

AVERAGE PERCENT OF EXHAUST PARTICULATE COLLECTED BY ANDERSON IMPACTOR BY STAGES FROM A MERCEDES 240D AND A VW RABBIT (DIESEL)

BY TEST PROCEDURE

TEST TYPE	STAGE 1	STAGE 2	STAGE 3	STAGE 4	STAGE 5	STAGE 6	STAGE 7	STAGE 8	STAGE 9	TOTAL PARTICULATE
M23885KH	.166	.217	.447	.447	1.291	2.237	3.771	3.618	87.805	7.823
M23985KH	.716	.351	.506	.955	1.461	2.459	3.386	3.512	86.654	7.118
M24085KH	.097	.697	.600	.568	1.379	1.768	2.303	3.228	89.359	6.165
M24185KH	.447	.671	.871	.857	.750	2.462	3.219	4.053	86.670	9.267
M24285KH	.049	.210	.618	.741	.717	2.064	4.041	3.497	88.064	8.093
V23985KH	.407	.407	.678	.753	1.130	2.259	2.410	2.711	89.245	6.639
V24085KH	.151	.108	.710	.473	.989	.925	1.527	1.613	93.504	4.649
V24185KH	.189	.325	.755	.625	.924	1.718	2.727	4.210	88.527	7.683
V24285KH	.029	.292	.438	.511	.656	1.896	2.261	2.640	91.276	6.855
AVER.	.250	.364	.625	.659	1.033	1.976	2.849	3.231	89.012	7.144
VMAX.	.716	.697	.871	.955	1.461	2.462	4.041	4.210	93.504	9.267
VMIN.	.029	.108	.438	.447	.656	.925	1.527	1.613	86.654	4.649
S.D.	.228	.202	.145	.178	.299	.480	.813	.804	2.211	1.308
RANGE	.687	.590	.433	.508	.805	1.537	2.513	2.597	6.850	4.618
VARI.	90.927	55.330	23.260	27.020	28.932	24.304	28.546	24.878	2.484	18.308

CUMULATIVE PERCENT OF EXHAUST PARTICULATE
COLLECTED BY ANDERSON IMPACTOR BY STAGES
FROM A MERCEDES 240D AND A VW RABBIT (DIESEL)

BY VEHICLE

TEST TYPE	STAGE 1	STAGE 2	STAGE 3	STAGE 4	STAGE 5	STAGE 6	STAGE 7	STAGE 8	STAGE 9	TOTAL PARTICULATE
M238FTPC	100.000	99.296	99.055	96.293	93.939	91.010	87.210	83.633	79.926	5.395
M238FTPH	100.000	99.453	98.915	97.659	95.114	92.942	90.108	86.922	83.103	4.820
M238CFDS	100.000	99.566	98.797	97.329	95.718	92.809	89.393	85.339	81.511	6.169
M238FET	100.000	99.847	99.323	97.720	95.617	93.788	90.951	87.485	83.119	5.126
M238NYCC	100.000	98.526	96.591	93.453	89.657	86.000	81.393	77.332	75.745	1.549
M238IDLE	100.000	97.416	96.382	96.382	95.952	93.798	92.076	89.492	86.477	1.161
M23850KH	100.000	99.385	98.678	98.063	97.295	95.911	94.221	91.915	88.995	3.253
M23885KH	100.000	99.834	99.617	99.169	98.722	97.431	95.194	91.423	87.805	7.823
M239FTPC	100.000	99.590	98.731	96.402	94.410	91.992	88.166	84.304	80.491	5.402
M239FTPH	100.000	99.516	98.908	97.512	95.934	94.055	91.338	88.215	84.507	5.274
M239CFDS	100.000	99.813	99.436	98.699	97.263	95.107	91.921	88.166	84.139	7.080
M239FET	100.000	99.852	99.641	98.860	97.868	96.517	93.794	90.754	87.080	4.737
M239NYCC	100.000	99.715	99.573	99.003	97.578	95.940	94.088	90.171	86.610	1.404
M239IDLE	100.000	99.784	99.496	98.561	97.770	97.122	95.540	93.885	91.367	1.390
M23950KH	100.000	99.453	98.967	98.511	98.025	97.113	96.111	93.832	91.310	3.291
M23985KH	100.000	99.284	98.932	98.427	97.471	96.010	93.552	90.166	86.654	7.118
M240FTPC	100.000	99.809	99.171	96.740	94.634	92.513	88.881	86.017	82.920	4.414
M240FTPH	100.000	99.883	99.164	97.555	96.014	94.109	91.502	89.026	85.878	3.972
M240CFDS	100.000	99.850	99.263	97.786	95.954	93.698	89.933	86.457	82.729	5.518
M240FET	100.000	99.974	99.842	98.918	98.099	96.911	94.535	91.631	88.384	3.788
M240NYCC	100.000	99.771	98.970	97.826	96.110	93.822	90.961	88.101	83.524	.874
M240IDLE	100.000	99.061	97.300	94.953	91.667	88.498	86.033	81.690	78.404	.852
M24050KH	100.000	99.743	99.119	98.860	98.614	97.345	95.467	93.250	90.688	2.670
M24085KH	100.000	99.903	99.205	98.605	98.037	96.659	94.891	92.587	89.359	6.165
M241FTPC	100.000	99.539	98.725	96.349	93.901	91.370	87.467	83.303	78.942	5.934
M241FTPH	100.000	99.512	98.881	97.628	95.978	94.092	91.162	87.489	83.375	5.902
M241CFDS	100.000	99.814	99.301	97.336	95.208	92.319	88.155	83.479	78.599	8.400
M241FET	100.000	99.869	99.103	96.809	95.999	93.477	90.588	87.224	83.426	5.667
M241NYCC	100.000	98.592	97.393	94.317	90.563	88.060	83.577	80.136	75.860	1.918
M241IDLE	100.000	97.555	96.309	95.590	94.391	92.186	90.125	87.872	84.084	2.086
M24150KH	100.000	99.439	98.342	96.898	95.695	93.850	91.230	88.289	84.840	3.740
M24185KH	100.000	99.553	98.882	98.011	97.154	96.404	93.942	90.723	86.670	9.267
M242FTPC	100.000	99.462	98.523	95.387	92.316	89.006	85.229	81.702	77.968	4.892
M242FTPH	100.000	99.588	98.847	96.795	94.795	92.497	89.696	86.807	83.391	4.444
M242CFDS	100.000	99.735	99.072	96.653	94.333	91.836	87.681	83.720	79.124	6.708
M242FET	100.000	99.886	99.705	98.456	96.957	95.117	92.278	88.667	84.942	4.403
M242NYCC	100.000	98.769	97.127	94.733	91.997	89.330	85.089	82.421	79.343	1.462
M242IDLE	100.000	99.421	97.484	96.663	95.783	94.317	90.377	84.658	76.932	.822
M24250KH	100.000	99.637	99.003	98.376	97.765	97.064	95.610	93.353	90.640	2.781
M24285KH	100.000	99.451	99.741	99.123	98.381	97.665	95.601	91.561	88.064	8.093
AVER.	100.000	99.466	98.738	97.310	95.717	93.742	90.877	87.580	83.923	4.394
VMAX.	100.000	99.974	99.842	99.169	98.722	97.665	96.111	93.885	91.367	9.267
VMIN.	100.000	97.416	96.309	93.453	89.657	86.000	81.393	77.332	75.745	.822
S.D.	.000	.574	.922	1.410	2.202	2.059	3.606	4.013	4.342	2.300
RANGE	.000	2.558	3.533	5.716	9.065	11.665	14.718	16.553	15.622	8.445
VARI.	.000	.577	.934	1.449	2.301	3.050	3.968	4.582	5.174	52.335

CUMULATIVE PERCENT OF EXHAUST PARTICULATE
COLLECTED BY ANDERSON IMPACTOR BY STAGES
FROM A MERCEDES 240D AND A VW RABBIT (DIESEL)

BY VEHICLE

TEST TYPE	STAGE 1	STAGE 2	STAGE 3	STAGE 4	STAGE 5	STAGE 6	STAGE 7	STAGE 8	STAGE 9	TOTAL PARTICULATE
V238FTPC	100.000	99.335	98.334	94.965	91.435	87.905	82.981	78.633	75.081	3.879
V238FTPH	100.000	98.453	96.645	92.960	90.059	85.519	80.700	76.564	71.681	2.830
V238CFDS	100.000	99.052	97.831	94.417	91.108	87.555	82.120	76.868	72.889	6.525
V238FET	100.000	99.138	98.726	93.518	92.094	89.659	87.224	83.252	80.817	2.669
V238NYCC	100.000	98.805	96.655	92.593	89.606	87.336	80.765	76.464	71.087	.837
V23850KH	100.000	98.446	98.343	97.877	97.670	97.048	95.805	94.252	92.957	1.931
V239FTPC	100.000	99.089	97.318	93.630	40.062	86.359	81.052	76.426	72.487	4.080
V239FTPH	100.000	99.455	98.596	96.546	94.522	91.882	87.741	84.766	81.954	3.148
V239CFDS	100.000	99.274	98.202	95.622	92.803	89.201	84.937	80.517	76.753	6.013
V239FFT	100.000	99.401	99.222	97.994	96.976	95.479	93.533	92.066	90.120	3.340
V239NYCC	100.000	99.698	96.777	95.267	92.246	86.506	81.873	77.241	74.421	.993
V239IDLE	100.000	99.796	99.080	98.730	98.337	97.041	96.107	94.881	93.202	1.000
V23950KH	100.000	98.517	96.595	95.772	94.454	93.410	91.653	90.445	87.919	1.821
V23985KH	100.000	99.593	99.187	98.509	97.756	96.626	94.367	91.957	89.245	6.639
V240FTPC	100.000	99.409	97.878	94.339	90.800	87.155	82.127	78.716	75.950	3.401
V240FTPH	100.000	99.794	99.276	97.104	95.446	93.214	89.822	87.689	86.007	2.582
V240CFDS	100.000	99.432	98.308	94.775	91.369	87.716	82.459	79.068	75.984	5.027
V240FET	100.000	98.852	97.816	95.981	94.625	93.156	91.145	89.486	87.668	3.134
V240NYCC	100.000	97.399	93.614	89.065	85.445	79.962	74.581	72.089	68.186	.652
V240IDLE	100.000	99.448	93.923	92.818	90.055	87.569	87.017	84.530	81.768	.362
V24050KH	100.000	99.852	99.852	99.704	99.409	99.039	98.374	97.044	94.826	1.353
V24085KH	100.000	99.849	99.742	99.032	98.559	97.569	96.644	95.117	93.504	4.649
V241FTPC	100.000	99.519	97.934	95.764	93.942	91.450	88.189	84.948	76.869	8.506
V241FTPH	100.000	99.287	98.282	95.666	92.716	89.980	86.620	84.235	81.866	3.871
V241CFDS	100.000	99.305	98.301	95.698	93.698	91.404	88.275	85.238	81.645	6.471
V241FET	100.000	99.508	99.261	98.498	97.267	95.618	92.861	90.399	87.346	4.062
V241NYCC	100.000	98.615	96.993	91.408	87.434	86.112	84.594	82.975	81.430	1.250
V241IDLE	100.000	98.426	97.663	96.469	92.967	92.528	91.878	91.767	91.253	1.819
V24150KH	100.000	99.697	99.493	99.107	98.814	98.731	98.414	97.815	94.236	12.868
V24185KH	100.000	99.811	99.486	98.731	98.106	97.182	95.464	92.738	88.527	7.683
V242FTPC	100.000	99.333	97.456	94.397	91.277	87.433	82.627	78.756	75.247	3.268
V242FTPH	100.000	99.231	97.825	95.552	93.090	90.108	85.311	82.202	79.269	2.756
V242CFDS	100.000	99.938	98.794	96.591	95.344	93.806	91.416	88.963	86.718	4.811
V242FET	100.000	99.584	98.957	97.324	95.989	94.417	91.535	89.180	86.814	3.767
V242NYCC	100.000	99.537	98.221	96.514	93.584	90.742	88.387	85.929	83.153	.739
V242IDLE	100.000	98.359	96.335	94.475	93.666	93.033	92.230	91.050	87.773	.968
V24250KH	100.000	100.000	100.000	100.000	99.772	99.201	97.603	96.461	92.466	.876
V24285KH	100.000	99.971	99.679	99.241	98.731	98.074	96.178	93.917	91.276	6.855
AVER.	100.000	99.269	98.068	95.965	93.980	91.756	88.805	86.175	83.168	3.617
VMAX.	100.000	100.000	100.000	100.000	99.772	99.201	98.414	97.815	94.826	12.868
VMIN.	100.000	97.399	93.614	89.065	85.445	79.962	74.581	72.089	68.186	.362
S.D.	.000	.564	1.429	2.460	3.504	4.648	6.026	7.004	7.625	2.655
RANGE	.000	2.601	6.386	10.935	14.326	19.239	23.833	25.726	26.640	12.506
VARI.	.000	.568	1.457	2.564	3.728	5.066	6.785	8.127	9.168	73.398

CUMULATIVE PERCENT OF EXHAUST PARTICULATE
COLLECTED BY ANDERSON IMPACTOR BY STAGES
FROM A MERCEDES 240D AND A VW RABBIT (DIESEL)

BY FUEL

TEST TYPE	STAGE 1	STAGE 2	STAGE 3	STAGE 4	STAGE 5	STAGE 6	STAGE 7	STAGE 8	STAGE 9	TOTAL PARTICULATE
M238FTPC	100.000	99.296	99.055	96.293	93.939	91.010	87.210	83.633	79.926	5.395
M238FTPH	100.000	99.453	98.915	97.659	95.114	92.942	90.108	86.922	83.103	4.820
M238CFDS	100.000	99.566	98.797	97.329	95.718	92.809	89.393	85.339	81.511	6.169
M238FET	100.000	99.847	99.323	97.720	95.617	93.788	90.951	87.485	83.119	5.126
M238NYCC	100.000	98.526	96.591	93.453	89.657	86.000	81.393	77.332	75.745	1.549
M238IDLE	100.000	97.416	96.382	96.382	95.952	93.798	92.076	89.492	86.477	1.161
M23850KM	100.000	99.385	98.678	98.063	97.295	95.911	94.221	91.915	88.995	3.253
M23885KM	100.000	99.834	99.617	99.169	98.722	97.431	95.194	91.423	87.805	7.823
V238FTPC	100.000	99.335	98.334	94.965	91.435	87.905	82.981	78.633	75.081	3.879
V238FTPH	100.000	98.453	96.645	92.960	90.059	85.519	80.700	76.564	71.681	2.830
V238CFDS	100.000	99.052	97.831	94.417	91.108	87.555	82.120	76.868	72.889	6.525
V238FET	100.000	99.138	98.726	93.518	92.094	89.659	87.224	83.252	80.817	2.669
V238NYCC	100.000	98.805	96.655	92.593	89.606	87.336	80.765	76.464	71.087	.837
V23850KM	100.000	98.446	98.343	97.877	97.670	97.048	95.805	94.252	92.957	1.931
AVER.	100.000	99.039	98.135	95.886	93.856	91.336	87.867	84.255	80.800	3.855
VMAX.	100.000	99.847	99.617	99.169	98.722	97.431	95.805	94.252	92.957	7.823
VMIN.	100.000	97.416	96.382	92.593	89.606	85.519	80.700	76.464	71.087	.837
S.D.	.000	.660	1.116	2.191	3.153	4.065	5.499	6.273	6.831	2.172
RANGE	.000	2.431	3.234	6.577	9.116	11.912	15.105	17.788	21.870	6.986
VARI.	.000	.666	1.137	2.285	3.359	4.451	6.258	7.445	8.454	56.355

TEST TYPE	STAGE 1	STAGE 2	STAGE 3	STAGE 4	STAGE 5	STAGE 6	STAGE 7	STAGE 8	STAGE 9	TOTAL PARTICULATE
M239FTPC	100.000	99.590	98.731	96.402	94.410	91.992	88.166	84.304	80.491	5.402
M239FTPH	100.000	99.516	98.908	97.512	95.934	94.055	91.338	88.215	84.507	5.274
M239CFDS	100.000	99.813	99.436	98.699	97.263	95.107	91.921	88.166	84.139	7.080
M239FET	100.000	99.852	99.641	98.860	97.868	96.517	93.794	90.754	87.080	4.737
M239NYCC	100.000	99.715	99.573	99.003	97.578	95.940	94.088	90.171	86.610	1.404
M239IDLE	100.000	99.784	99.496	98.561	97.770	97.122	95.540	93.885	91.367	1.390
M23950KM	100.000	99.453	98.967	98.511	98.025	97.113	96.111	93.832	91.310	3.291
M23985KM	100.000	99.284	98.932	98.427	97.471	96.010	93.552	90.166	86.654	7.118
V239FTPC	100.000	99.089	97.318	93.630	90.062	86.359	81.052	76.426	72.487	4.080
V239FTPH	100.000	99.455	98.596	96.546	94.522	91.882	87.741	84.766	81.954	3.148
V239CFDS	100.000	99.274	98.202	95.622	92.803	89.201	84.937	80.517	76.753	6.013
V239FET	100.000	99.401	99.222	97.994	96.976	95.479	93.533	92.066	90.120	3.340
V239NYCC	100.000	99.698	96.777	95.267	92.246	86.506	81.873	77.241	74.421	.993
V239IDLE	100.000	99.796	99.080	98.730	98.337	97.041	96.107	94.881	93.202	1.000
V23950KM	100.000	98.517	96.595	95.772	94.454	93.410	91.653	90.445	87.919	1.821
V23985KM	100.000	99.593	99.187	98.509	97.756	96.626	94.367	91.957	89.245	6.639
AVER.	100.000	99.489	98.666	97.378	95.842	93.772	90.986	87.987	84.891	3.921
VMAX.	100.000	99.852	99.641	99.003	98.337	97.122	96.111	94.881	93.202	7.118
VMIN.	100.000	98.517	96.595	93.630	90.062	86.359	81.052	76.426	72.487	.993
S.D.	.000	.340	.963	1.626	2.487	3.640	4.854	5.780	6.202	2.195
RANGE	.000	1.335	3.046	5.373	8.274	10.764	15.059	18.455	20.715	6.125
VARI.	.000	.342	.976	1.670	2.594	3.882	5.335	6.569	7.306	55.984

CUMULATIVE PERCENT OF EXHAUST PARTICULATE
COLLECTED BY ANDERSON IMPACTOR BY STAGES
FROM A MERCEDES 240D AND A VW RABBIT (DIESEL)

BY FUEL

TEST TYPE	STAGE 1	STAGE 2	STAGE 3	STAGE 4	STAGE 5	STAGF 6	STAGE 7	STAGE 8	STAGE 9	TOTAL PARTICULATE
M240FTPC	100.000	99.809	99.171	96.740	94.634	92.513	88.881	86.017	82.920	4.414
M240FTPH	100.000	99.883	99.164	97.555	96.014	94.109	91.502	89.026	85.878	3.972
M240CFDS	100.000	99.850	99.263	97.786	95.954	93.698	89.933	86.457	82.729	5.518
M240FET	100.000	99.974	99.842	98.918	98.099	96.911	94.535	91.631	88.384	3.788
M240NYCC	100.000	99.771	98.970	97.826	96.110	93.822	90.961	88.101	83.524	.874
M240IDLE	100.000	99.061	97.300	94.953	91.667	88.498	86.033	81.690	78.404	.852
M24050KH	100.000	99.743	99.119	98.860	98.614	97.345	95.467	93.250	90.688	2.670
M24085KH	100.000	99.903	99.205	98.605	98.037	96.659	94.891	92.587	89.359	6.165
V240FTPC	100.000	99.409	97.878	94.339	90.800	87.155	82.127	78.716	75.950	3.401
V240FTPH	100.000	99.794	99.276	97.104	95.446	93.214	89.822	87.689	86.007	2.582
V240CFDS	100.000	99.432	98.308	94.775	91.369	87.716	82.459	79.068	75.984	5.027
V240FET	100.000	98.852	97.816	95.981	94.625	93.156	91.145	89.486	87.668	3.134
V240NYCC	100.000	97.399	93.614	89.065	85.445	79.962	74.581	72.089	68.186	.652
V240IDLE	100.000	99.448	93.923	92.818	90.055	87.569	87.017	84.530	81.768	.362
V24050KH	100.000	99.852	99.852	99.704	99.409	99.039	98.374	97.044	94.826	1.353
V24085KH	100.000	99.849	99.742	99.032	98.559	97.569	96.644	95.117	93.504	4.649
AVER.	100.000	99.502	98.278	96.504	94.677	92.433	89.648	87.031	84.111	3.088
VMAX.	100.000	99.974	99.852	99.704	99.409	99.039	98.374	97.044	94.826	6.165
VMIN.	100.000	97.399	93.614	89.065	85.445	79.962	74.581	72.089	68.186	.362
S.D.	.000	.646	1.910	2.788	3.861	5.062	6.184	6.633	7.021	1.851
RANGE	.000	2.574	6.238	10.639	13.963	19.077	23.793	24.955	26.640	5.803
VARI.	.000	.649	1.943	2.889	4.078	5.476	6.898	7.621	8.348	59.944

TEST TYPE	STAGE 1	STAGE 2	STAGE 3	STAGE 4	STAGE 5	STAGE 6	STAGE 7	STAGE 8	STAGE 9	TOTAL PARTICULATE
M241FTPC	100.000	99.539	98.725	96.349	93.901	91.370	87.467	83.303	78.942	5.934
M241FTPH	100.000	99.512	98.881	97.628	95.978	94.092	91.162	87.489	83.375	5.902
M241CFDS	100.000	99.814	99.301	97.336	95.208	92.319	88.155	83.479	78.599	8.400
M241FET	100.000	99.869	99.103	96.809	95.999	93.477	90.588	87.224	83.426	5.667
M241NYCC	100.000	98.592	97.393	94.317	90.563	88.060	83.577	80.136	75.860	1.918
M241IDLE	100.000	97.555	96.309	95.590	94.391	92.186	90.125	87.872	84.084	2.086
M24150KH	100.000	99.439	98.342	96.898	95.695	93.850	91.230	88.289	84.840	3.740
M24185KH	100.000	99.553	98.882	98.011	97.154	96.404	93.942	90.723	86.670	9.267
V241FTPC	100.000	99.519	97.934	95.764	93.942	91.450	88.189	84.948	76.869	8.506
V241FTPH	100.000	99.287	98.282	95.666	92.716	89.980	86.620	84.235	81.866	3.871
V241CFDS	100.000	99.305	98.301	95.698	93.698	91.404	88.275	85.238	81.645	6.471
V241FET	100.000	99.508	99.261	98.498	97.267	95.618	92.861	90.399	87.346	4.062
V241NYCC	100.000	98.615	96.993	91.408	87.434	86.112	84.599	82.975	81.430	1.250
V241IDLE	100.000	98.426	97.663	96.469	92.967	92.528	91.878	91.767	91.253	1.819
V24150KH	100.000	99.697	99.493	99.107	98.814	98.731	98.414	97.815	94.236	12.868
V24185KH	100.000	99.811	99.486	98.731	98.106	97.182	95.464	92.738	88.527	7.683
AVER.	100.000	99.253	98.397	96.517	94.615	92.798	90.159	87.414	83.686	5.591
VMAX.	100.000	99.869	99.493	99.107	98.814	98.731	98.414	97.815	94.236	12.868
VMIN.	100.000	97.555	96.309	91.408	87.434	86.112	83.577	80.136	75.860	1.250
S.D.	.000	.634	.936	1.892	2.884	3.268	3.905	4.489	5.064	3.223
RANGE	.000	2.313	3.184	7.699	11.380	12.619	14.837	17.679	18.376	11.618
VARI.	.000	.639	.951	1.960	3.048	3.522	4.331	5.136	6.051	57.651

CUMULATIVE PERCENT OF EXHAUST PARTICULATE
COLLECTED BY ANDERSON IMPACTOR BY STAGES
FROM A MERCEDES 240D AND A VW RABBIT (DIESEL)

BY FUEL

TEST TYPE	STAGE 1	STAGE 2	STAGE 3	STAGE 4	STAGE 5	STAGE 6	STAGE 7	STAGE 8	STAGE 9	TOTAL PARTICULATE
M242FTPC	100.000	99.462	98.523	95.387	92.316	89.006	85.229	81.702	77.968	4.892
M242FTPH	100.000	99.588	98.847	96.795	94.795	92.497	89.696	86.807	83.391	4.444
M242CFDS	100.000	99.735	99.072	96.653	94.333	91.836	87.681	83.720	79.124	6.708
M242FFT	100.000	99.886	99.705	98.456	96.957	95.117	92.278	88.667	84.442	4.403
M242NYCC	100.000	98.769	97.127	94.733	91.497	89.330	85.089	82.421	79.343	1.462
M242IDLE	100.000	99.421	97.484	96.663	95.783	94.317	90.377	84.658	76.932	.822
M2425OKH	100.000	99.637	99.003	98.376	97.765	97.064	95.610	93.353	90.640	2.781
M2428SKH	100.000	99.951	99.741	99.123	98.381	97.665	95.601	91.561	88.064	8.093
V242FTPC	100.000	99.333	97.456	94.397	91.277	87.433	82.627	78.756	75.247	3.268
V242FTPH	100.000	99.231	97.825	95.552	93.090	90.108	85.311	82.202	79.269	2.756
V242CFDS	100.000	99.938	98.794	96.591	95.344	93.806	91.416	88.963	86.718	4.811
V242FFT	100.000	99.584	98.957	97.324	95.989	94.417	91.535	89.180	86.814	3.767
V242NYCC	100.000	99.537	98.221	96.514	93.584	90.742	88.387	85.929	83.153	.739
V242IDLE	100.000	98.359	96.335	94.475	93.666	93.033	92.230	91.050	87.773	.968
V2425OKH	100.000	100.000	100.000	100.000	99.772	99.201	97.603	96.461	92.466	.876
V2428SKH	100.000	99.971	99.679	99.241	98.731	98.074	96.178	93.917	91.276	6.855
AVER.	100.000	99.525	98.548	96.892	95.236	93.353	90.428	87.459	83.945	3.603
VMAX.	100.000	100.000	100.000	100.000	99.772	99.201	97.603	96.461	92.466	8.093
VMIN.	100.000	98.359	96.335	94.397	91.277	87.433	82.627	78.756	75.247	.739
S.D.	.000	.450	1.059	1.754	2.561	3.510	4.486	5.036	5.462	2.328
RANGE	.000	1.641	3.665	5.603	8.495	11.768	14.975	17.705	17.219	7.353
VARI.	.000	.452	1.074	1.810	2.690	3.760	4.961	5.758	6.507	64.605

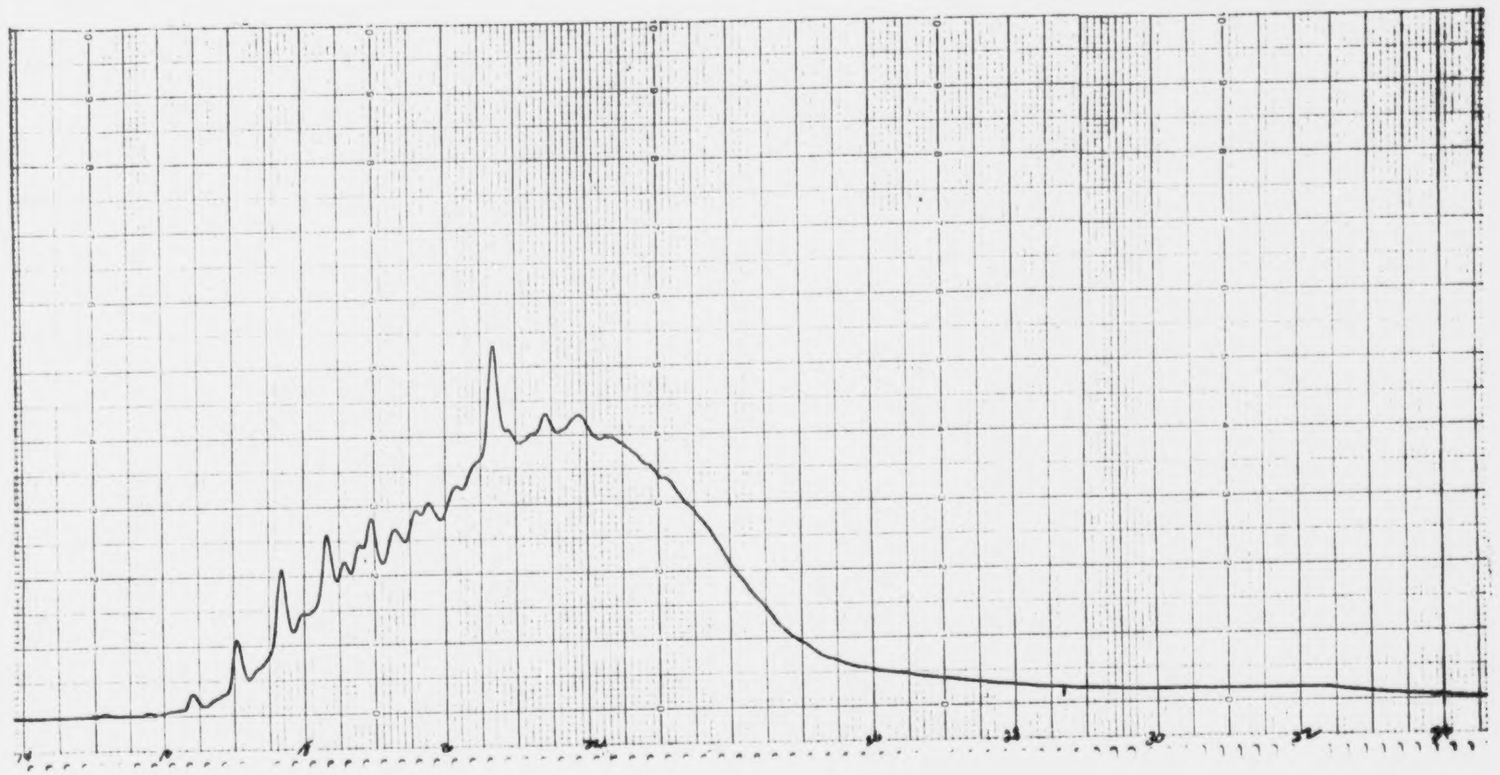

Figure G-19. Chromatogram of organic solubles from particulate matter,

Mercedes 240D operated on EM-241-F fuel (repeat)

CUMULATIVE PERCENT OF EXHAUST PARTICULATE
COLLECTED BY ANDERSON IMPACTOR BY STAGES
FROM A MERCEDES 240D AND A VW RABBIT (DIESEL)

BY TEST PROCEDURE

TEST TYPE	STAGE 1	STAGE 2	STAGE 3	STAGE 4	STAGE 5	STAGE 6	STAGE 7	STAGE 8	STAGE 9	TOTAL PARTICULATE
M238FTPC	100.000	99.296	99.055	96.293	93.939	91.010	87.210	83.633	79.926	5.395
M239FTPC	100.000	99.590	98.731	96.402	94.410	91.992	88.166	84.304	80.491	5.402
M240FTPC	100.000	99.809	99.171	96.740	94.634	92.513	88.881	86.017	82.920	4.414
M241FTPC	100.000	99.539	98.725	96.349	93.901	91.370	87.467	83.303	78.942	5.934
M242FTPC	100.000	99.462	98.523	95.387	92.316	89.006	85.229	81.702	77.968	4.892
V238FTPC	100.000	99.335	98.334	94.465	91.435	87.905	82.981	78.633	75.081	3.879
V239FTPC	100.000	99.089	97.318	93.630	90.062	86.359	81.052	76.426	72.487	4.080
V240FTPC	100.000	99.409	97.878	94.339	90.800	87.155	82.127	78.716	75.950	3.401
V241FTPC	100.000	99.519	97.934	95.764	93.942	91.450	88.189	84.948	76.869	8.506
V242FTPC	100.000	99.333	97.456	94.397	91.277	87.433	82.627	78.756	75.247	3.268
AVER.	100.000	99.438	98.313	95.427	92.672	89.619	85.393	81.644	77.588	4.917
VMAX.	100.000	99.809	99.171	96.740	94.634	92.513	88.881	86.017	82.920	8.506
VMIN.	100.000	99.089	97.318	93.630	90.062	86.359	81.052	76.426	72.487	3.268
S.D.	.000	.195	.644	1.058	1.684	2.289	2.949	3.283	3.078	1.543
RANGE	.000	.719	1.853	3.110	4.572	6.155	7.830	9.591	10.433	5.238
VARI.	.000	.196	.655	1.109	1.817	2.554	3.454	4.022	3.968	31.381

CUMULATIVE PERCENT OF EXHAUST PARTICULATE
COLLECTED BY ANDERSON IMPACTOR BY STAGES
FROM A MERCEDES 240D AND A VW RABBIT (DIESEL)

BY TEST PROCEDURE

TEST TYPE	STAGE 1	STAGE 2	STAGE 3	STAGE 4	STAGE 5	STAGE 6	STAGE 7	STAGE 8	STAGE 9	TOTAL PARTICULATE
M238FTPH	100.000	99.453	98.915	97.659	95.114	92.942	90.108	86.922	83.103	4.820
M239FTPH	100.000	99.516	98.908	97.512	95.934	94.055	91.338	88.215	84.507	5.274
M240FTPH	100.000	99.883	99.164	97.555	96.014	94.109	91.502	89.026	85.878	3.972
M241FTPH	100.000	99.512	98.881	97.628	95.978	94.092	91.162	87.489	83.375	5.902
M242FTPH	100.000	99.588	98.847	96.795	94.795	92.497	89.696	86.807	83.391	4.444
V238FTPH	100.000	98.453	96.645	92.960	90.059	85.519	80.700	76.564	71.681	2.830
V239FTPH	100.000	99.455	98.596	96.546	94.522	91.882	87.741	84.766	81.954	3.148
V240FTPH	100.000	99.794	99.276	97.104	95.446	93.214	89.022	87.689	86.007	2.582
V241FTPH	100.000	99.287	98.282	95.666	92.716	89.980	86.620	84.235	81.866	3.871
V242FTPH	100.000	99.231	97.825	95.552	93.090	90.108	85.311	82.202	79.269	2.756
AVER.	100.000	99.417	98.534	96.498	94.367	91.840	88.400	85.392	82.103	3.960
VMAX.	100.000	99.883	99.276	97.659	96.014	94.109	91.502	89.026	86.007	5.902
VMIN.	100.000	98.453	96.645	92.960	90.059	85.519	80.700	76.564	71.681	2.582
S.D.	.000	.393	.788	1.465	1.903	2.689	3.415	3.727	4.167	1.143
RANGE	.000	1.429	2.631	4.698	5.954	8.590	10.802	12.463	14.326	3.320
VARI.	.000	.395	.800	1.519	2.017	2.928	3.863	4.365	5.075	28.871

CUMULATIVE PERCENT OF EXHAUST PARTICULATE COLLECTED BY ANDERSON IMPACTOR BY STAGES FROM A MERCEDES 240D AND A VW RABBIT (DIESEL)

BY TEST PROCEDURE

TEST TYPE	STAGE 1	STAGE 2	STAGE 3	STAGE 4	STAGE 5	STAGE 6	STAGE 7	STAGE 8	STAGE 9	TOTAL PARTICULATE
M238CFDS	100.000	99.566	98.797	97.329	95.718	92.809	89.393	85.339	81.511	6.169
M239CFDS	100.000	99.813	99.436	98.699	97.263	95.107	91.921	88.166	84.139	7.080
M240CFDS	100.000	99.850	99.263	97.786	95.954	93.698	89.933	86.457	82.729	5.518
M241CFDS	100.000	99.814	99.301	97.336	95.208	92.319	88.155	83.479	78.599	8.400
M242CFDS	100.000	99.735	99.072	96.653	94.333	91.836	87.681	83.720	79.124	6.708
V238CFDS	100.000	99.052	97.831	94.417	91.108	87.555	82.120	76.868	72.889	6.525
V239CFDS	100.000	99.274	98.202	95.622	92.803	89.201	84.937	80.517	76.753	6.013
V240CFDS	100.000	99.432	98.308	94.775	91.369	87.716	82.459	79.068	75.984	5.027
V241CFDS	100.000	99.305	98.301	95.698	93.698	91.404	88.275	85.238	81.645	6.471
V242CFDS	100.000	99.938	98.794	96.591	95.344	93.806	91.416	88.963	86.718	4.811
AVER.	100.000	99.578	98.731	96.491	94.280	91.545	87.629	83.782	80.009	6.272
VMAX.	100.000	99.938	99.436	98.699	97.263	95.107	91.921	88.963	86.718	8.400
VMIN.	100.000	99.052	97.831	94.417	91.108	87.555	82.120	76.868	72.889	4.811
S.D.	.000	.299	.546	1.359	2.023	2.599	3.435	3.923	4.145	1.044
RANGE	.000	.885	1.605	4.282	6.155	7.552	9.800	12.095	13.829	3.589
VARI.	.000	.300	.553	1.409	2.145	2.840	3.920	4.683	5.181	16.644

CUMULATIVE PERCENT OF EXHAUST PARTICULATE COLLECTED BY ANDERSON IMPACTOR BY STAGES FROM A MERCEDES 240D AND A VW RABBIT (DIESEL)

BY TEST PROCEDURE

TEST TYPE	STAGE 1	STAGE 2	STAGE 3	STAGE 4	STAGE 5	STAGE 6	STAGE 7	STAGE 8	STAGE 9	TOTAL PARTICULATE
M238FET	100.000	99.847	99.323	97.720	95.617	93.788	90.951	87.485	83.119	5.126
M239FET	100.000	99.852	99.641	98.860	97.868	96.517	93.794	90.754	87.080	4.737
M240FET	100.000	99.974	99.842	98.918	98.099	96.911	94.535	91.631	88.384	3.788
M241FET	100.000	99.869	99.103	96.809	95.999	93.477	90.588	87.224	83.426	5.667
M242FET	100.000	99.886	99.705	98.456	96.957	95.117	92.278	88.667	84.942	4.403
V238FET	100.000	99.138	98.726	93.518	92.094	89.659	87.224	83.252	80.817	2.669
V239FET	100.000	99.401	99.222	97.994	96.976	95.479	93.533	92.066	90.120	3.340
V240FET	100.000	98.852	97.816	95.981	94.625	93.156	91.145	89.486	87.668	3.134
V241FET	100.000	99.508	99.261	98.498	97.267	95.618	92.861	90.399	87.346	4.062
V242FET	100.000	99.584	98.957	97.324	95.989	94.417	91.535	89.180	86.814	3.767
AVER.	100.000	99.591	99.159	97.408	96.149	94.919	91.844	89.014	85.972	4.069
VMAX.	100.000	99.974	99.842	98.918	98.099	96.911	94.535	92.066	90.120	5.667
VMIN.	100.000	98.852	97.816	93.518	92.094	89.659	87.224	83.252	80.817	2.669
S.D.	.000	.371	.584	1.655	1.778	2.087	2.093	2.587	2.828	.929
RANGE	.000	1.121	2.026	5.399	6.005	7.252	7.312	8.814	9.303	2.998
VARI.	.000	.372	.589	1.699	1.849	2.210	2.279	2.906	3.290	22.825

CUMULATIVE PERCENT OF EXHAUST PARTICULATE
COLLECTED BY ANDERSON IMPACTOR BY STAGES
FROM A MERCEDES 240D AND A VW RABBIT (DIESEL)

BY TEST PROCEDURE

TEST TYPE	STAGE 1	STAGE 2	STAGE 3	STAGE 4	STAGE 5	STAGE 6	STAGE 7	STAGE 8	STAGE 9	TOTAL PARTICULATE
M238NYCC	100.000	98.526	96.591	93.453	89.657	86.000	81.393	77.332	75.745	1.549
M239NYCC	100.000	99.715	99.573	99.003	97.578	95.940	94.088	90.171	86.610	1.409
M240NYCC	100.000	99.771	98.970	97.826	96.110	93.822	90.961	88.101	83.524	.874
M241NYCC	100.000	98.592	97.393	94.317	90.563	88.060	83.577	80.136	75.860	1.918
M242NYCC	100.000	98.769	97.127	94.733	91.997	89.330	85.089	82.421	79.343	1.462
V238NYCC	100.000	98.805	96.655	92.593	89.606	87.336	80.765	76.464	71.087	.837
V239NYCC	100.000	99.698	96.777	95.267	92.246	86.506	81.873	77.241	74.421	.993
V240NYCC	100.000	97.399	93.614	89.065	85.445	79.962	74.581	72.089	68.186	.652
V241NYCC	100.000	98.615	96.993	91.408	87.434	86.112	84.594	82.975	81.430	1.250
V242NYCC	100.000	99.537	98.221	96.514	93.584	90.742	88.387	85.929	83.153	.739
AVER.	100.000	98.943	97.191	94.418	91.422	88.381	84.531	81.286	77.936	1.168
VMAX.	100.000	99.771	99.573	99.003	97.578	95.440	94.088	90.171	86.610	1.918
VMIN.	100.000	97.399	93.614	89.065	85.445	79.962	74.581	72.089	68.186	.652
S.D.	.000	.748	1.619	2.978	3.717	4.467	5.567	5.698	5.881	.413
RANGE	.000	2.372	5.959	9.937	12.133	15.978	19.508	18.082	18.424	1.266
VARI.	.000	.756	1.666	3.154	4.066	5.055	6.585	7.010	7.546	35.343

CUMULATIVE PERCENT OF EXHAUST PARTICULATE
COLLECTED BY ANDERSON IMPACTOR BY STAGES
FROM A MERCEDES 240D AND A VW RABBIT (DIESEL)

BY TEST PROCEDURE

TEST TYPE	STAGE 1	STAGE 2	STAGE 3	STAGE 4	STAGE 5	STAGE 6	STAGE 7	STAGE 8	STAGE 9	TOTAL PARTICULATE
M238IDLE	100.000	97.416	96.382	96.382	95.952	93.798	92.076	89.492	86.477	1.161
M239IDLE	100.000	99.784	99.496	98.561	97.770	97.122	95.540	93.885	91.367	1.390
M240IDLE	100.000	99.061	97.300	94.953	91.667	88.498	86.033	81.690	78.404	.852
M241IDLE	100.000	97.555	96.309	95.590	94.391	92.186	90.125	87.872	84.084	2.086
M242IDLE	100.000	99.421	97.484	96.663	95.783	94.317	90.377	84.658	76.932	.822
V239IDLE	100.000	99.796	99.080	98.730	98.337	97.041	96.107	94.881	93.202	1.000
V240IDLE	100.000	99.448	93.923	92.818	90.055	87.569	87.017	84.530	81.769	.362
V241IDLE	100.000	98.426	97.663	96.469	92.967	92.528	91.878	91.767	91.253	1.819
V242IDLE	100.000	98.359	96.335	94.475	93.666	93.033	92.230	91.050	87.773	.968
AVER.	100.000	98.807	97.108	96.071	94.510	92.899	91.265	88.869	85.696	1.162
VMAX.	100.000	99.796	99.496	98.730	98.337	97.122	96.107	94.881	93.202	2.086
VMIN.	100.000	97.416	93.923	92.818	90.055	87.569	86.033	81.690	76.932	.362
S.D.	.000	.911	1.658	1.887	2.739	3.284	3.376	4.527	5.834	.531
RANGE	.000	2.380	5.574	5.912	8.281	9.553	10.074	13.190	16.270	1.724
VARI.	.000	.922	1.707	1.964	2.898	3.535	3.699	5.094	6.808	45.658

CUMULATIVE PERCENT OF EXHAUST PARTICULATE
COLLECTED BY ANDERSON IMPACTOR BY STAGES
FROM A MERCEDES 240D AND A VW RABBIT (DIESEL)

BY TEST PROCEDURE

TEST TYPE	STAGE 1	STAGE 2	STAGE 3	STAGE 4	STAGE 5	STAGE 6	STAGE 7	STAGE 8	STAGE 9	TOTAL PARTICULATE
M2385OKM	100.000	99.385	98.678	98.063	97.295	95.911	94.221	91.915	88.995	3.253
M2395OKM	100.000	99.953	98.967	98.511	98.025	97.113	96.111	93.832	91.310	3.291
M2405OKM	100.000	99.793	99.119	98.860	98.614	97.345	95.467	93.250	90.688	2.670
M2415OKM	100.000	99.439	98.342	96.898	95.695	93.850	91.230	88.289	84.840	3.740
M2425OKM	100.000	99.637	99.003	98.376	97.765	97.064	95.610	93.353	90.640	2.781
V2385OKM	100.000	98.446	98.343	97.877	97.670	97.048	95.805	94.252	92.957	1.931
V2395OKM	100.000	98.517	96.595	95.772	94.454	93.410	91.653	90.445	87.919	1.821
V2405OKM	100.000	99.852	99.852	99.704	99.409	99.039	98.374	97.044	94.826	1.353
V2415OKM	100.000	99.697	99.493	99.107	98.814	98.731	98.414	97.815	94.236	12.868
V2425OKM	100.000	100.000	100.000	100.000	99.772	99.201	97.603	96.461	92.466	.876
AVER.	100.000	99.417	98.839	98.317	97.751	96.871	95.449	93.666	90.888	3.458
VMAX.	100.000	100.000	100.000	100.000	99.772	99.201	98.414	97.815	94.826	12.868
VMIN.	100.000	98.446	96.595	95.772	94.454	93.410	91.230	88.289	84.840	.876
S.D.	.000	.529	.971	1.268	1.636	1.999	2.501	2.971	3.032	3.430
RANGE	.000	1.554	3.405	4.228	5.318	5.791	7.184	9.526	9.987	11.992
VARI.	.000	.532	.982	1.290	1.674	2.064	2.620	3.172	3.336	99.181

CUMULATIVE PERCENT OF EXHAUST PARTICULATE
COLLECTED BY ANDERSON IMPACTOR BY STAGES
FROM A MERCEDES 240D AND A VW RABBIT (DIESEL)

BY TEST PROCEDURE

TEST TYPE	STAGE 1	STAGE 2	STAGE 3	STAGE 4	STAGE 5	STAGE 6	STAGE 7	STAGE 8	STAGE 9	TOTAL PARTICULATE
M2388SKM	100.000	99.834	99.617	99.169	98.722	97.431	95.194	91.423	87.805	7.823
M2398SKM	100.000	99.284	98.932	98.427	97.471	96.010	93.552	90.166	86.654	7.118
M2408SKM	100.000	99.903	99.205	98.605	98.037	96.659	94.891	92.587	89.359	6.165
M2418SKM	100.000	99.553	98.882	98.011	97.154	96.404	93.942	90.723	86.670	9.267
M2428SKM	100.000	99.951	99.741	99.123	98.381	97.665	95.601	91.561	88.064	8.093
V2398SKM	100.000	99.593	99.187	98.509	97.756	96.626	94.367	91.957	89.245	6.639
V2408SKM	100.000	99.849	99.742	99.032	98.559	97.569	96.644	95.117	93.504	4.649
V2418SKM	100.000	99.811	99.486	98.731	98.106	97.182	95.464	92.738	88.527	7.683
V2428SKM	100.000	99.971	99.679	99.241	98.731	98.074	96.178	93.917	91.276	6.856
AVER.	100.000	99.750	99.386	98.761	98.102	97.069	95.092	92.243	89.012	7.144
VMAX.	100.000	99.971	99.742	99.241	98.731	98.074	96.644	95.117	93.504	9.267
VMIN.	100.000	99.284	98.882	98.011	97.154	96.010	93.552	90.166	86.654	4.649
S.D.	.000	.228	.342	.413	.558	.679	1.016	1.552	2.211	1.308
RANGE	.000	.687	.860	1.231	1.577	2.064	3.093	4.951	6.850	4.618
VARI.	.000	.228	.344	.418	.568	.699	1.069	1.683	2.484	18.308

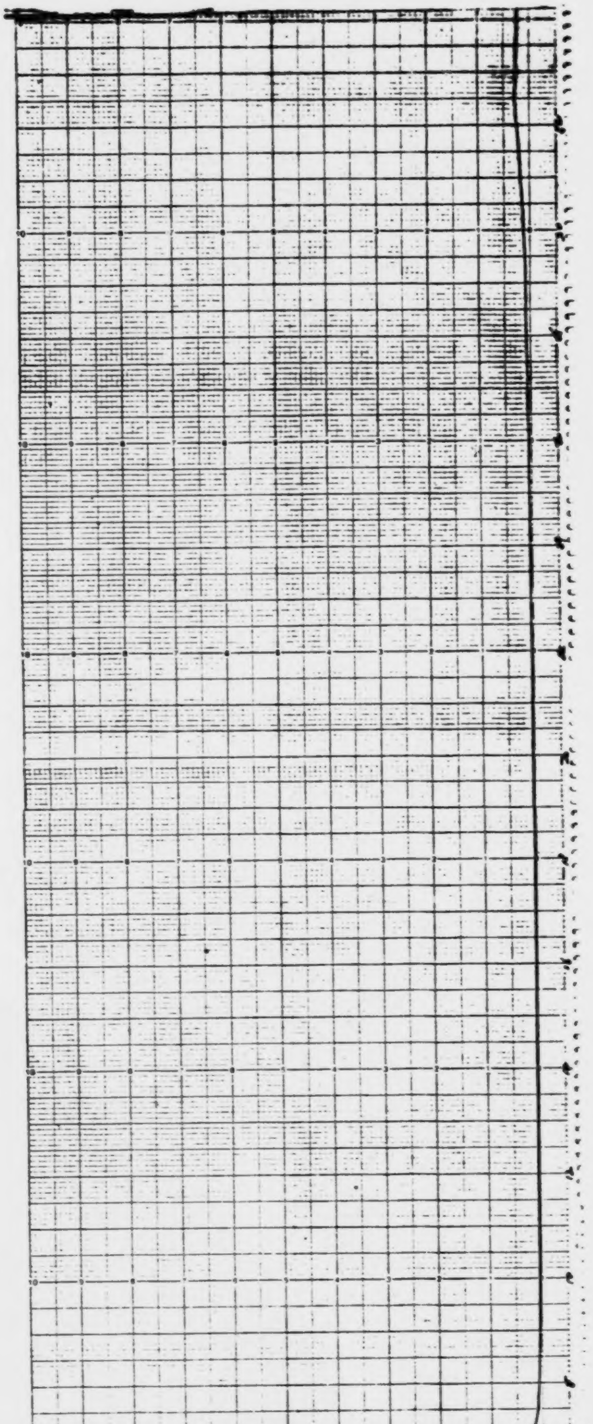

Figure G-9. Cyclohexane (solvent) blank output from high-temperature gas chromatograph run

C_9-C_{11} Standard Composition

Weight %	Compound	Boiling point, °C
20	n-nonane	151
19	4-methyl nonane	166
23	n-decane	174
19	2-methyl decane	189
19	n-undecane	196

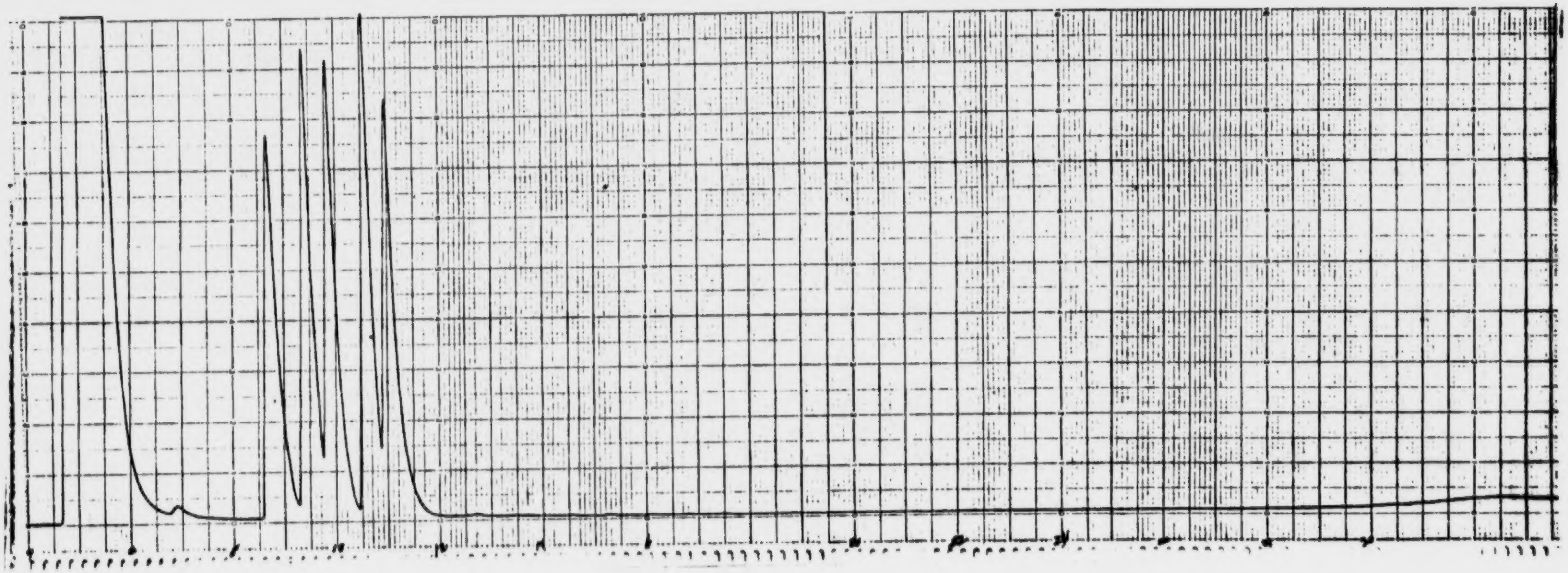

Figure G-10. Cyclohexane plus C_9-C_{11} internal standard on high-temperature gas chromatograph

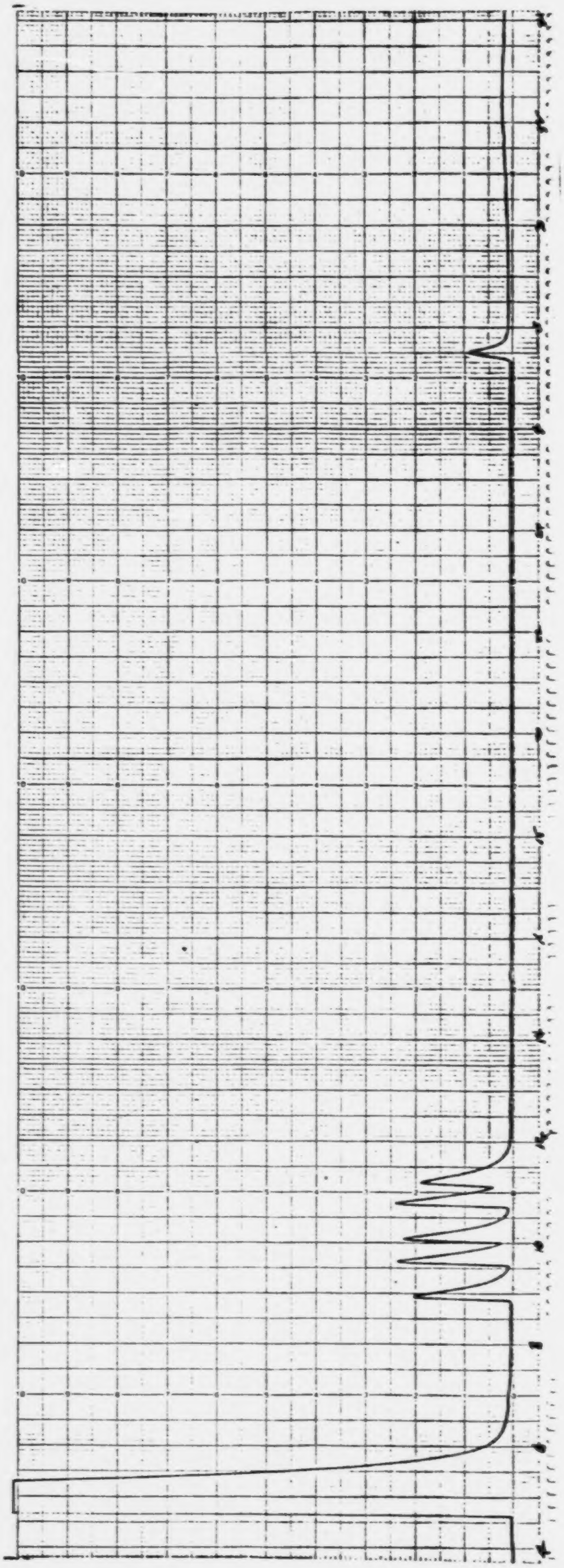

Figure G-11. Cyclohexane and internal standard with C_{40} spike on high-temperature gas chromatograph

Residue Standard Composition

Weight %	Component(s)	Boiling point(s), °C
30.6	C_9-C_{11}	151-196
10.9	n-C_{12}	216
8.0	n-C_{14}	254
5.5	n-C_{15}	271
6.6	n-C_{16}	287
6.3	n-C_{17}	302
7.7	n-C_{18}	316
4.7	n-C_{22}	369
6.2	n-C_{24}	391
2.6	n-C_{30}	449
3.1	n-C_{32}	466
4.1	n-C_{36}	496
3.7	n-C_{40}	522

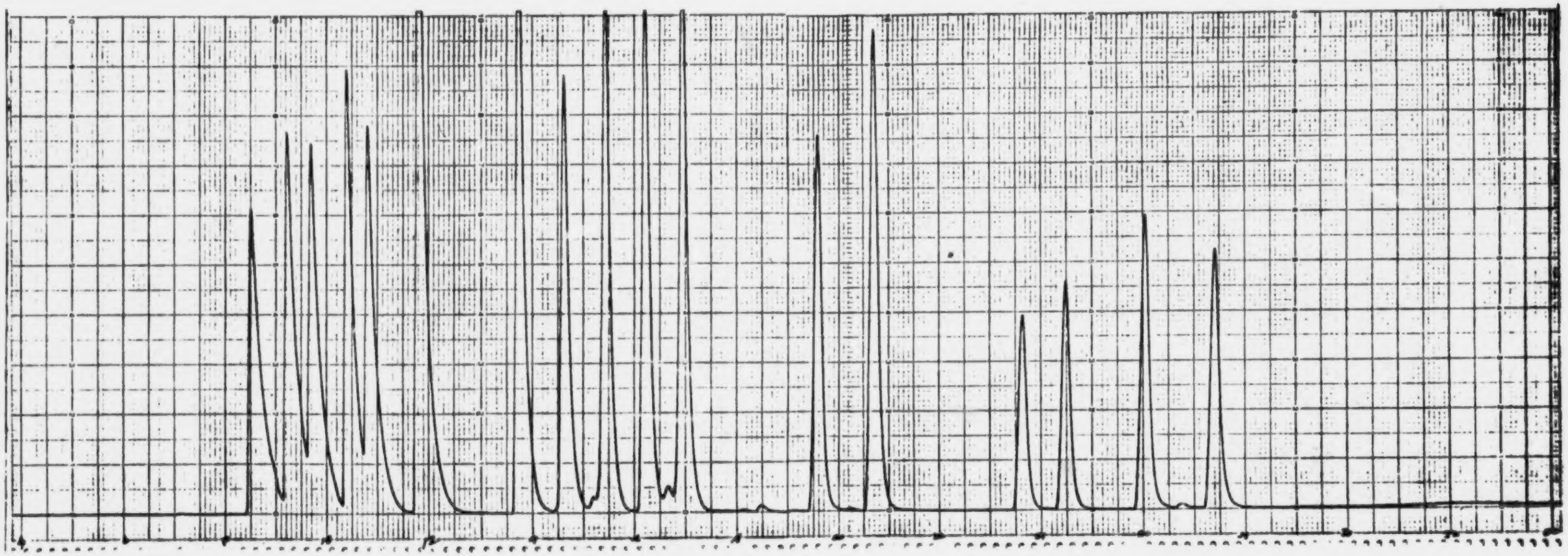

Figure G-12. Residue standard output from high-temperature gas chromatograph run

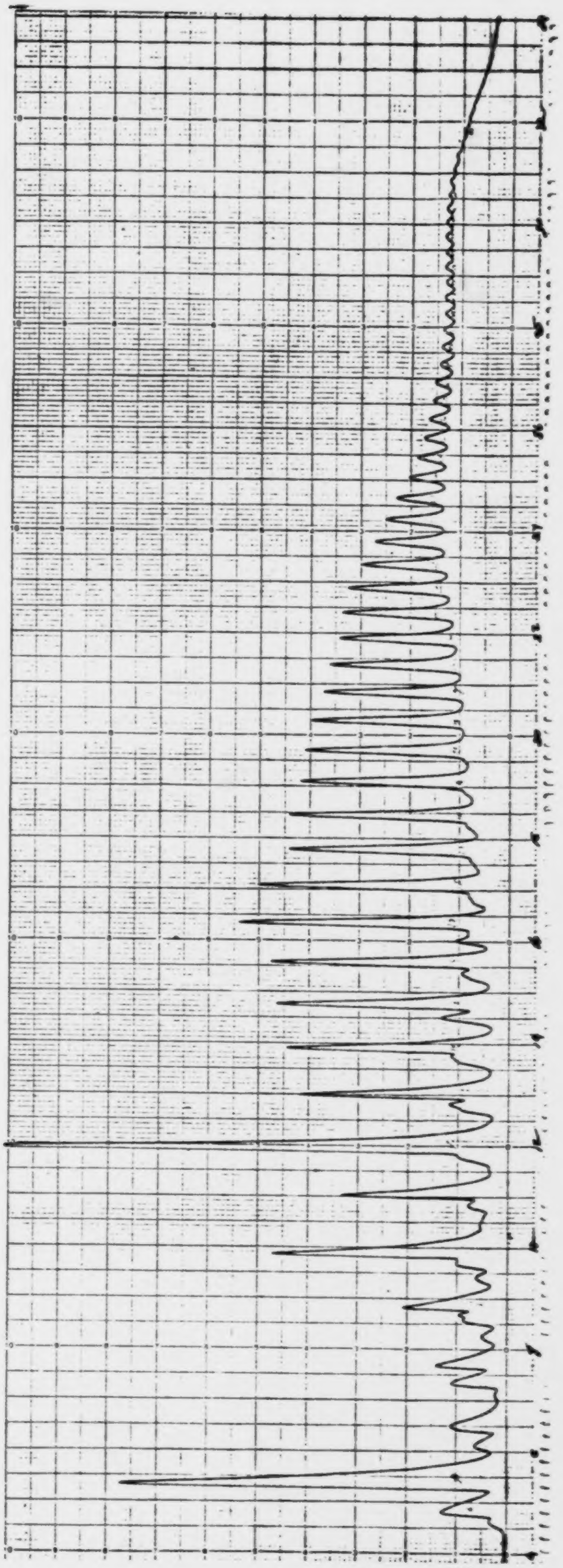

Figure G-13. "Altamont" crude oil output from high-temperature gas chromatograph run

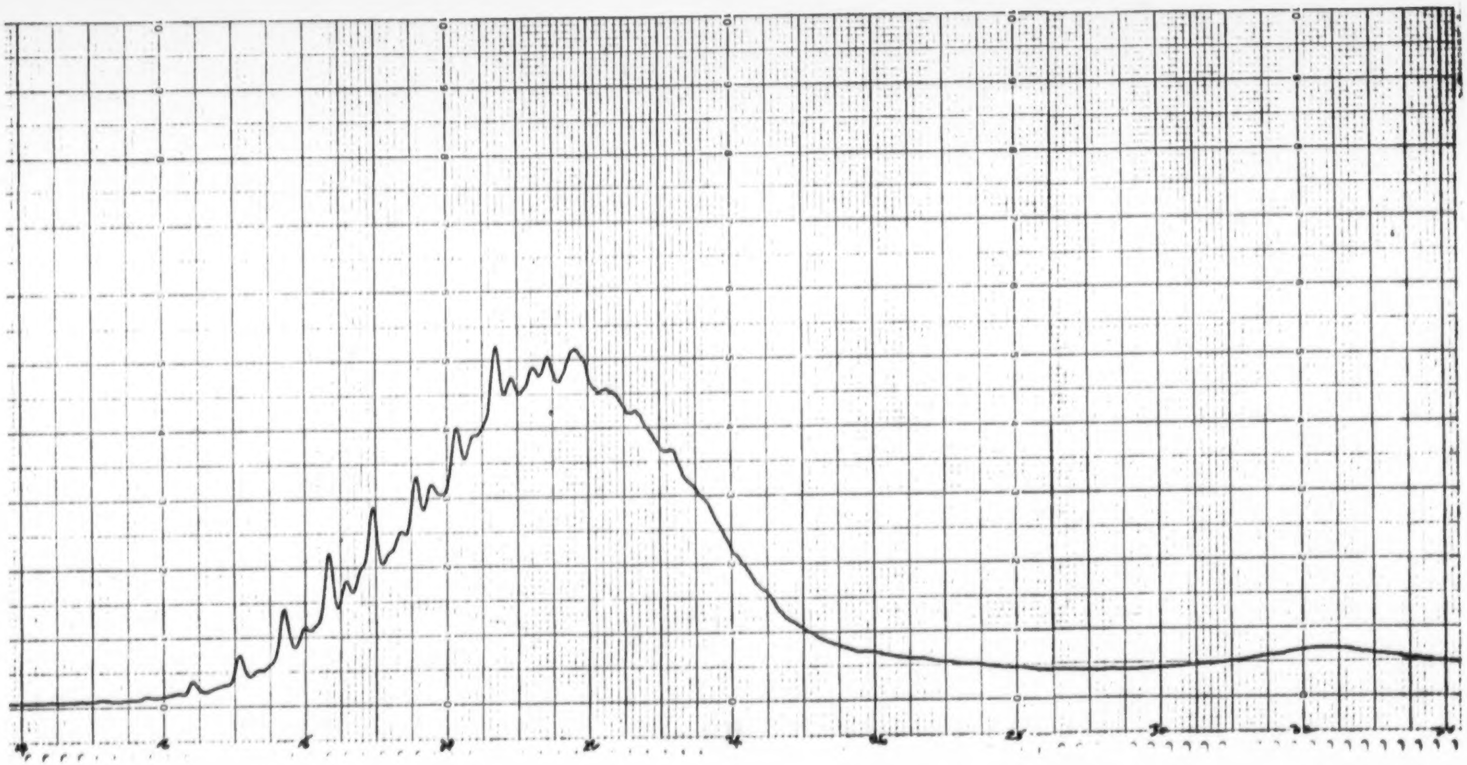

Figure G-14. Chromatogram of organic solubles from particulate matter, Mercedes 240D operated on EM-238-F fuel

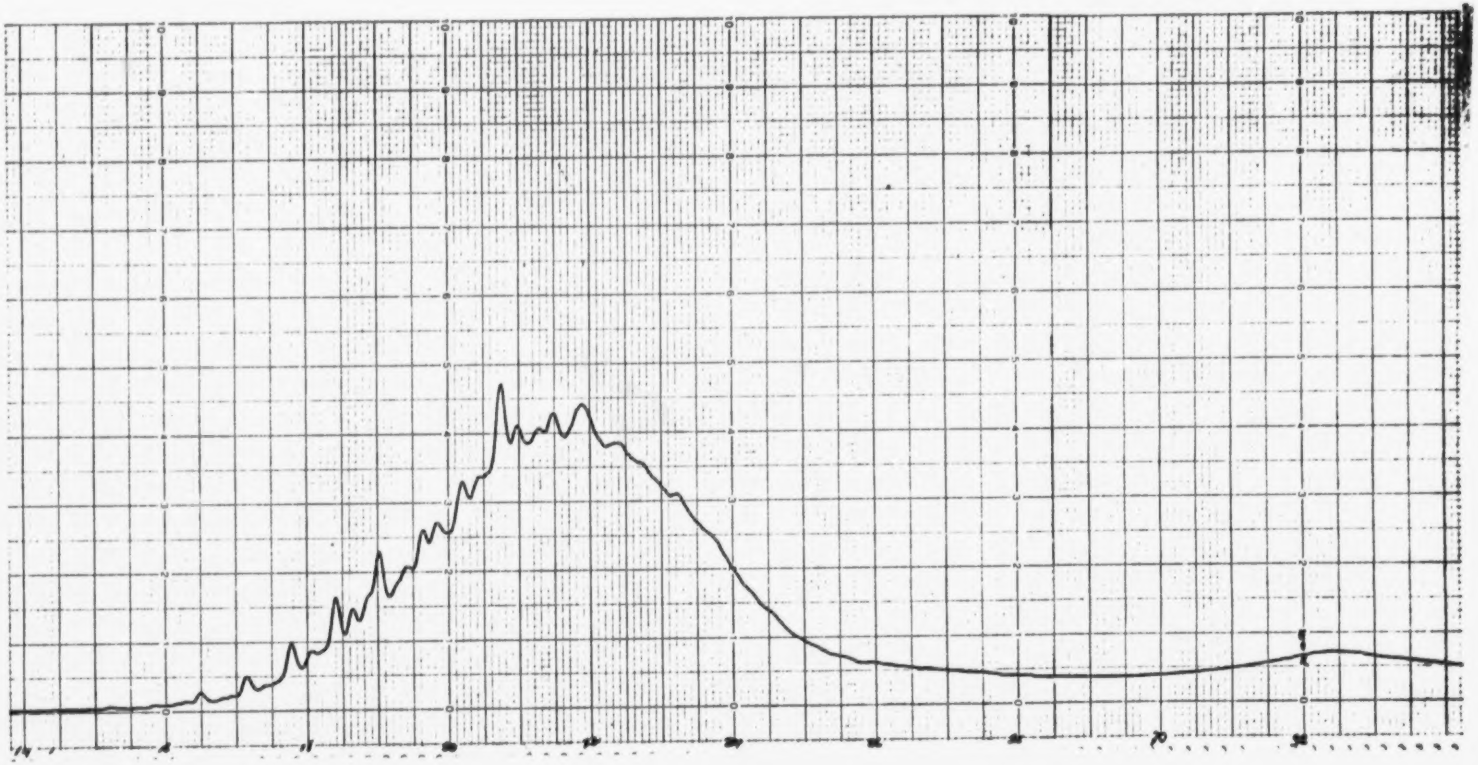

Figure G-15. Chromatogram of organic solubles from particulate matter, Mercedes 240D operated on EM-239-F fuel

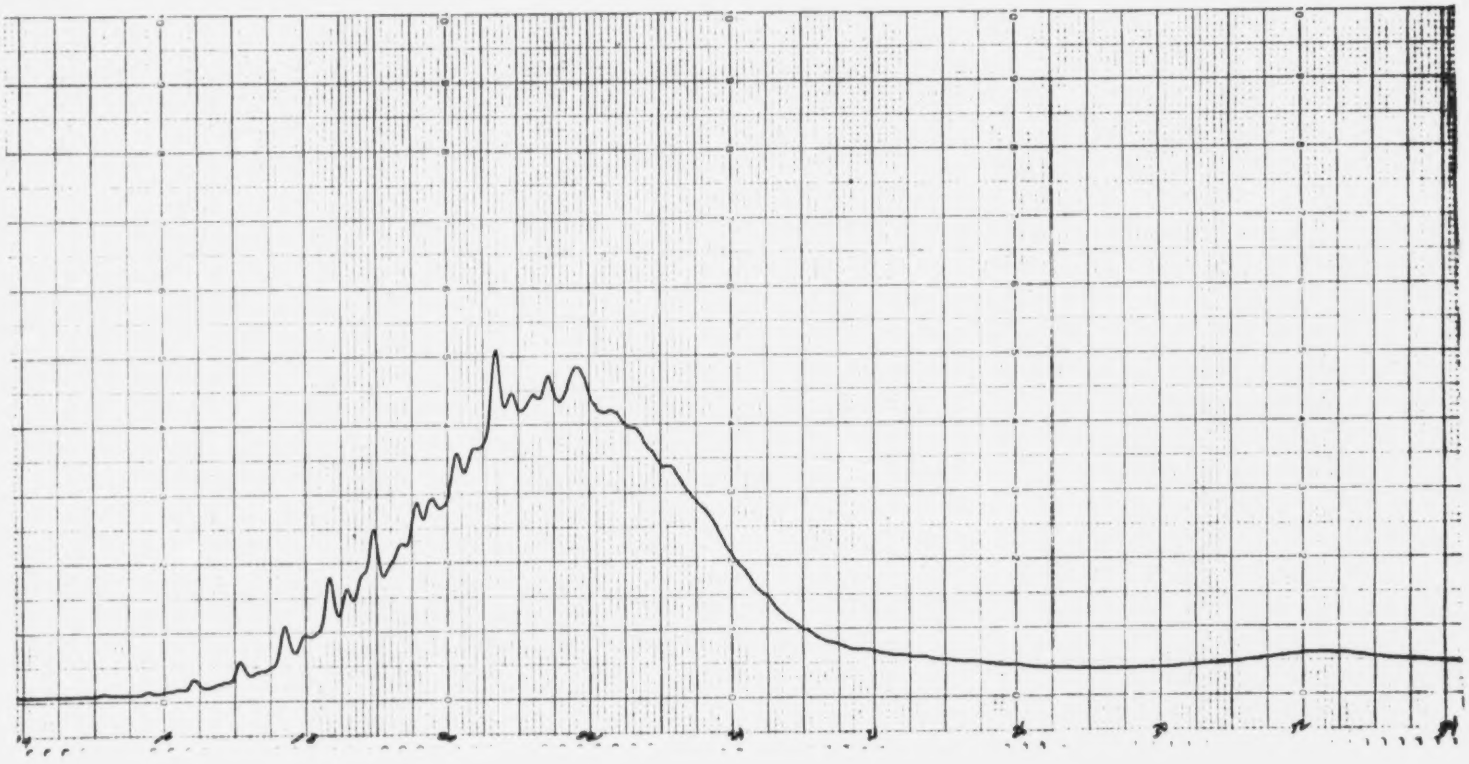

Figure G-16. Chromatogran of organic solubles from particulate matter, Mercedes 240D operated on EM-239-F fuel (repeat)

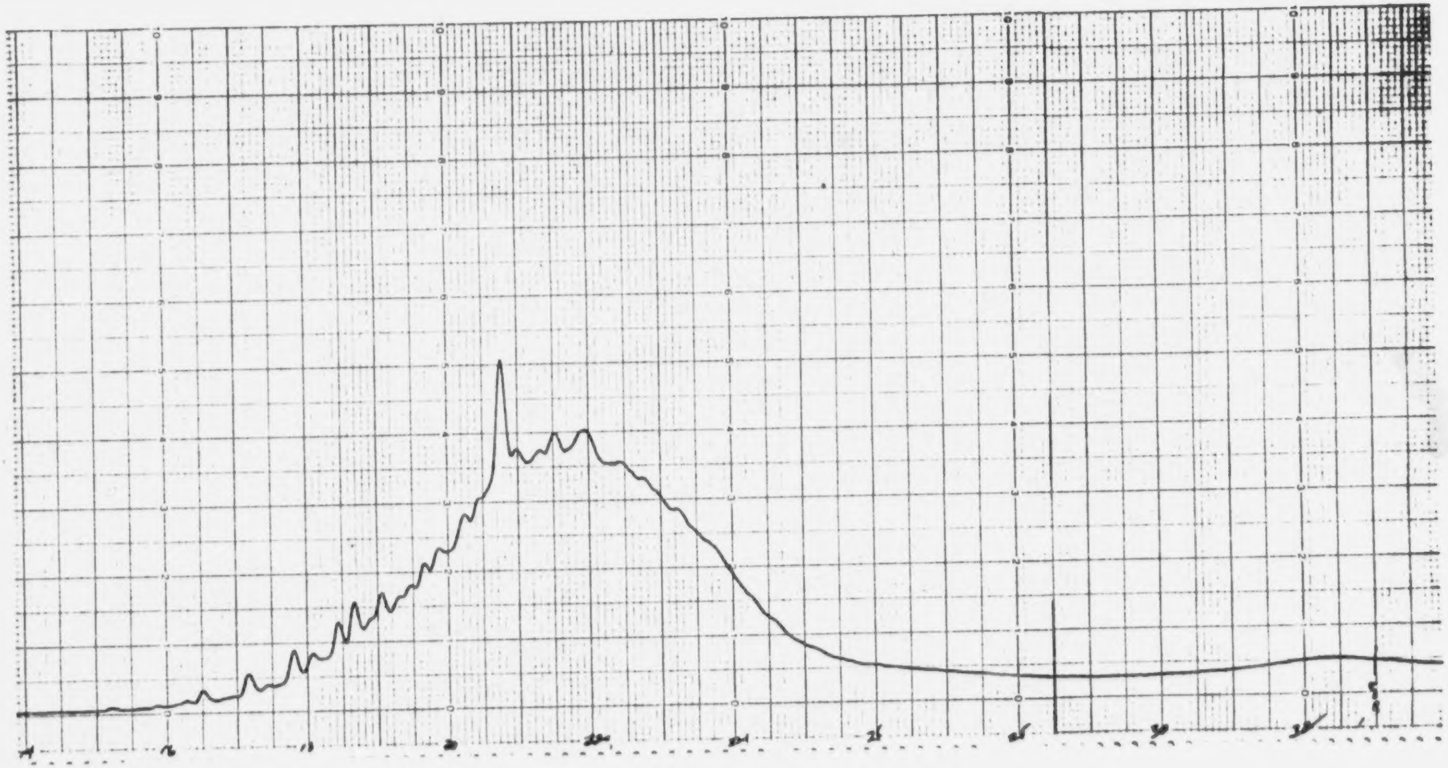

Figure G-17. Chromatogram of organic solubles from particulate matter, Mercedes 240D operated on EM-240-F fuel

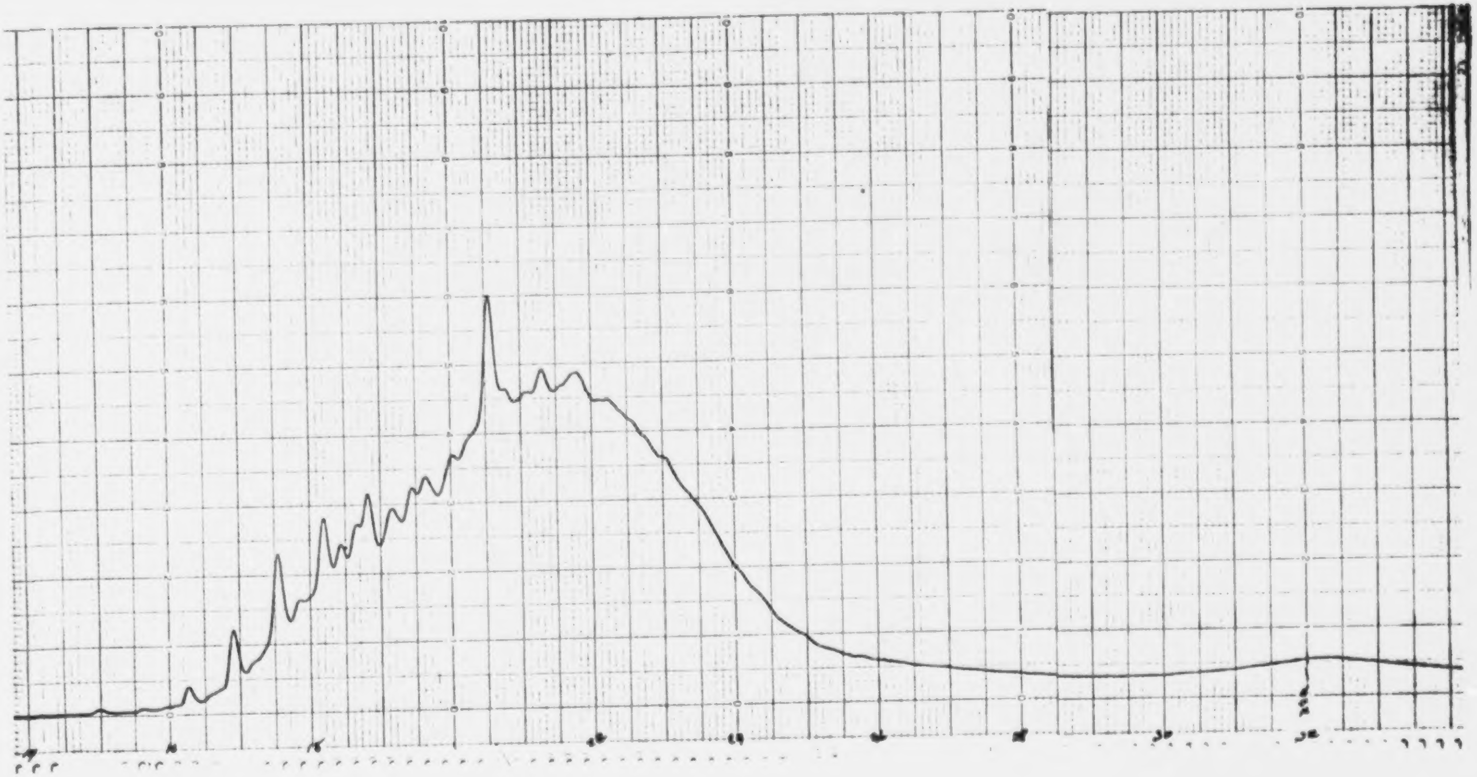

Figure G-18. Chromatogram of organic solubles from particulate matter, Mercedes 240D operated on EM-242-F fuel

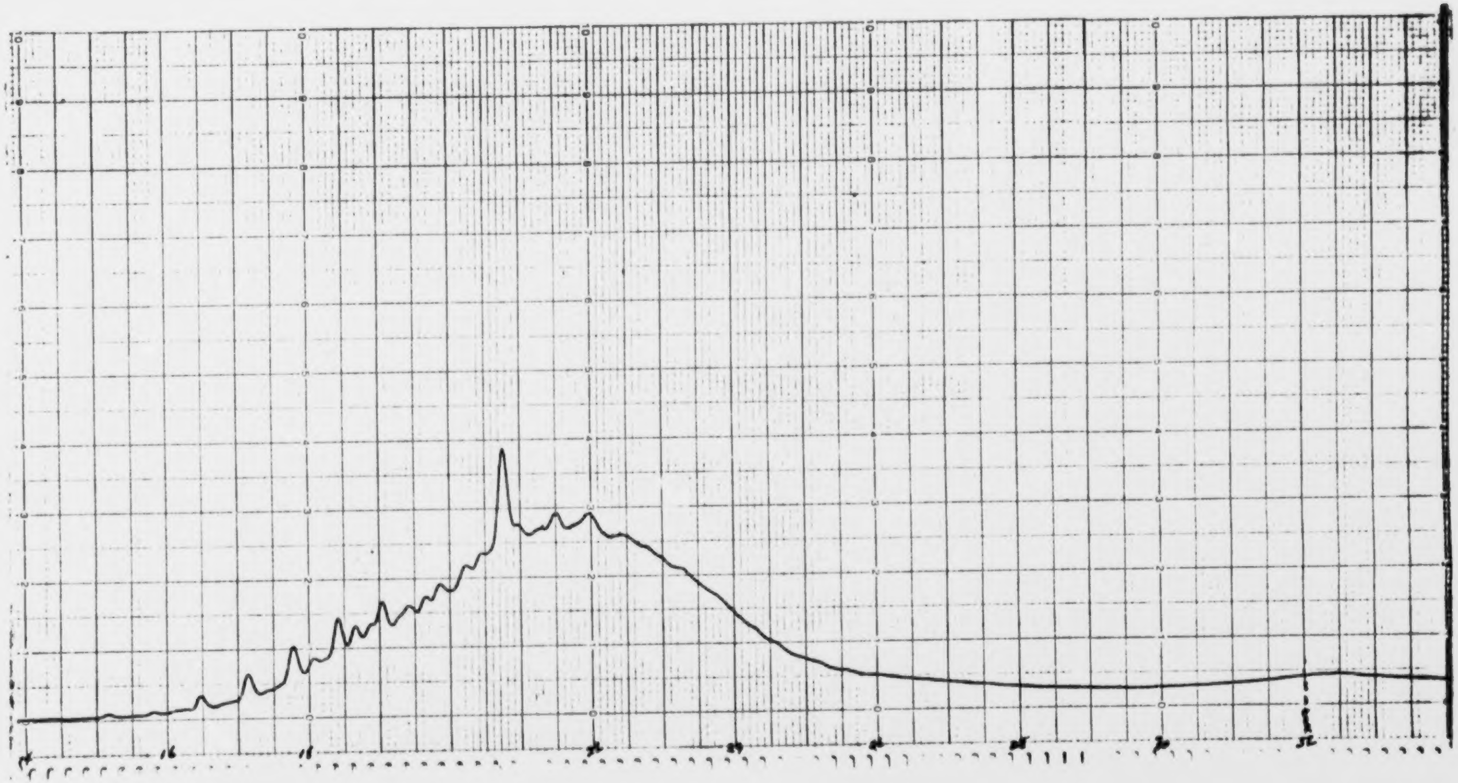

Figure G-20. Chromatogram of organic solubles from partiuclate matter,

Mercedes 240D operated on EM-242-F fuel

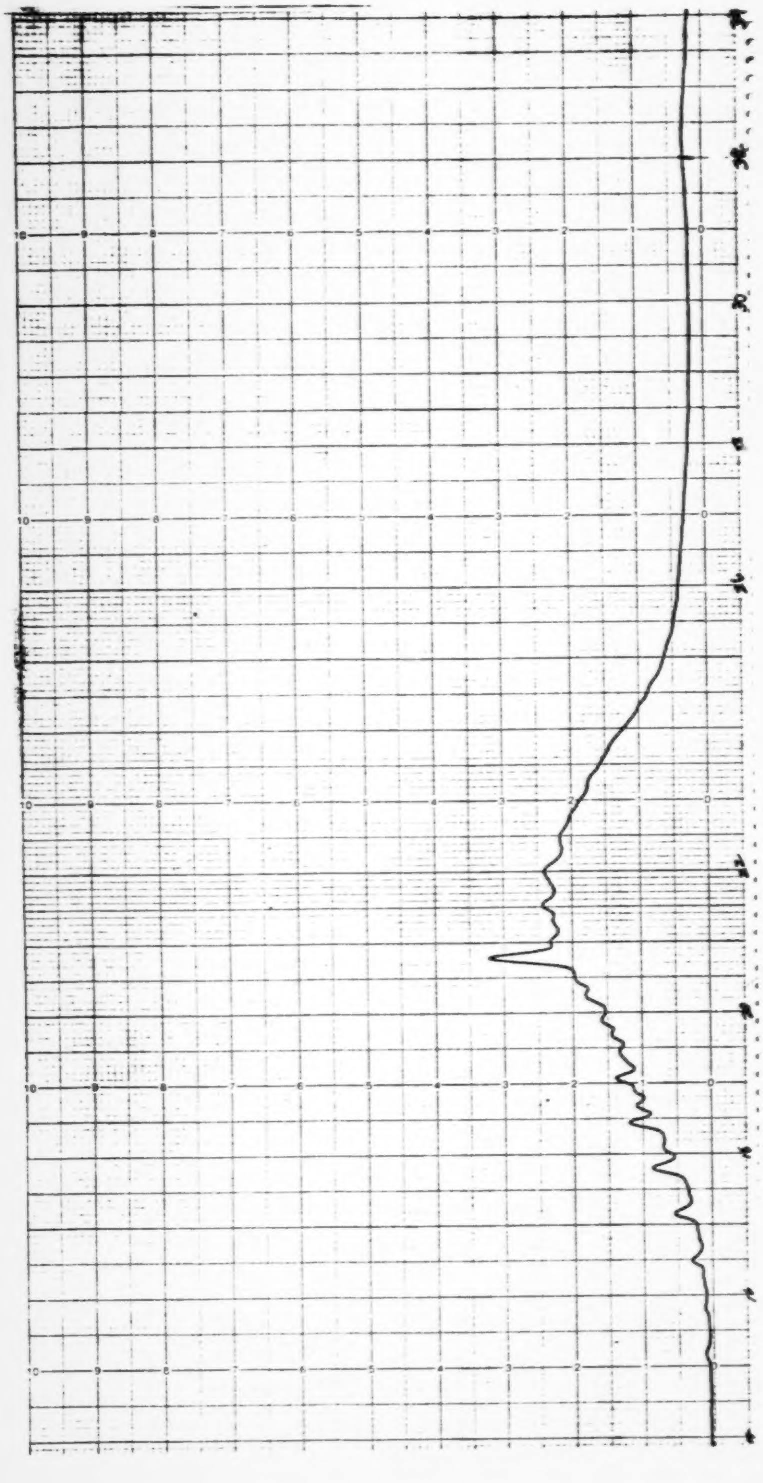

Figure G-21. Chromatogram of organic solubles from particulate matter, Mercedes 240D operated on EM-242-F fuel (repeat)

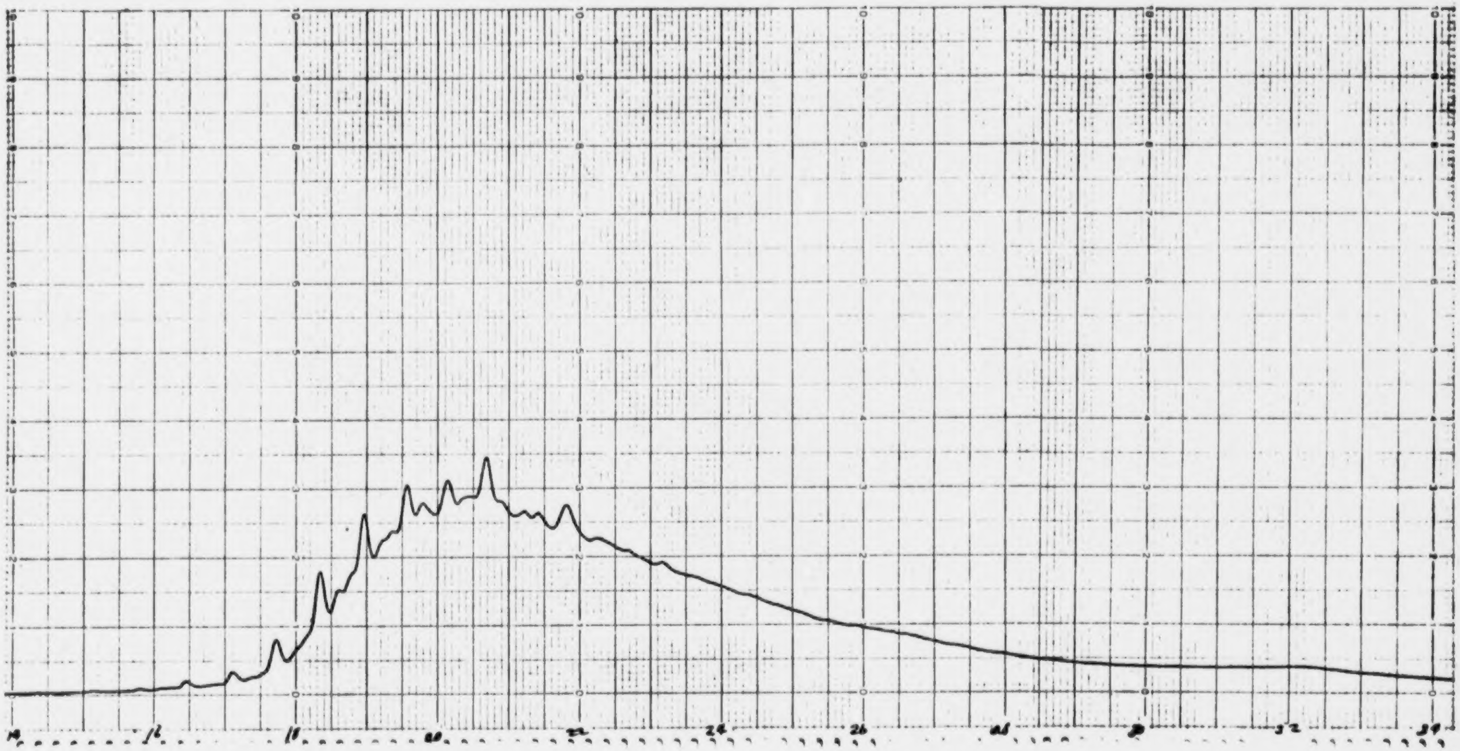

Figure G-22. Chromatogram of organic solubles from particulate matter,

Volkswagen Rabbit Diesel operated on EM-238-F fuel

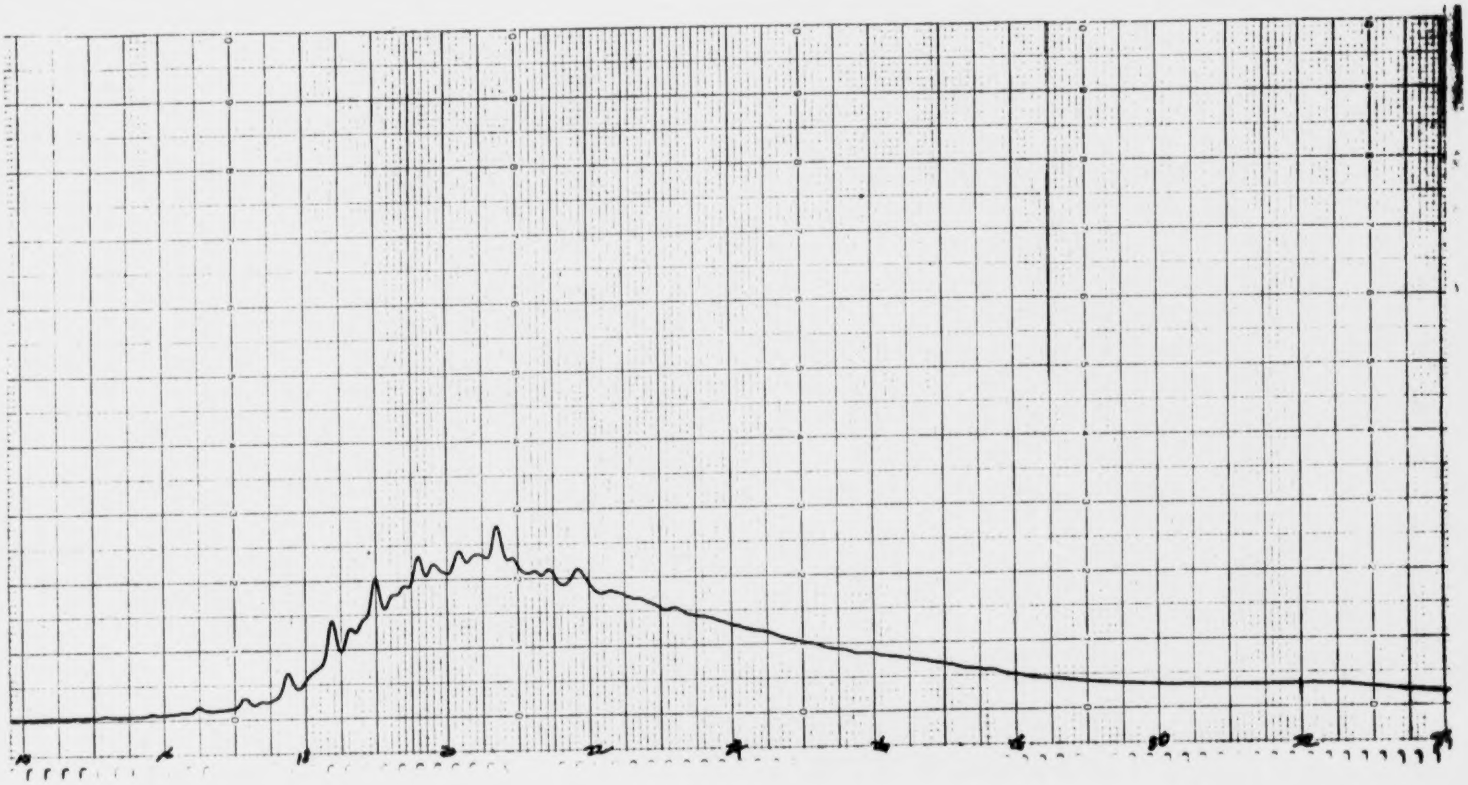

Figure G-23. Chromatogram of organic solubles from particulate matter,

Volkswagen Rabbit Diesel operated on EM-239-F fuel

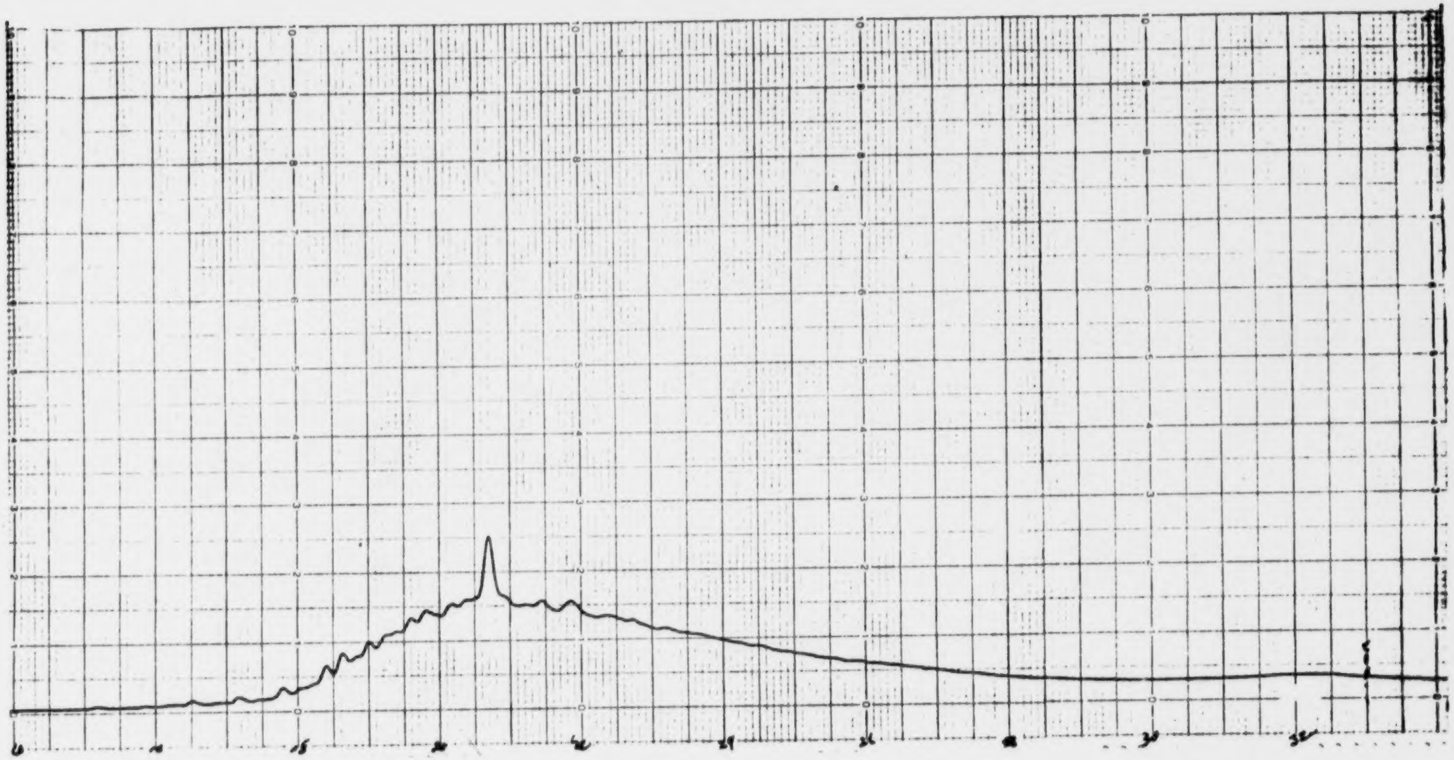

Figure G-24. Chromatogram of organic solubles from particulate matter, Volkswagen Rabbit Diesel operated on EM-240-F fuel

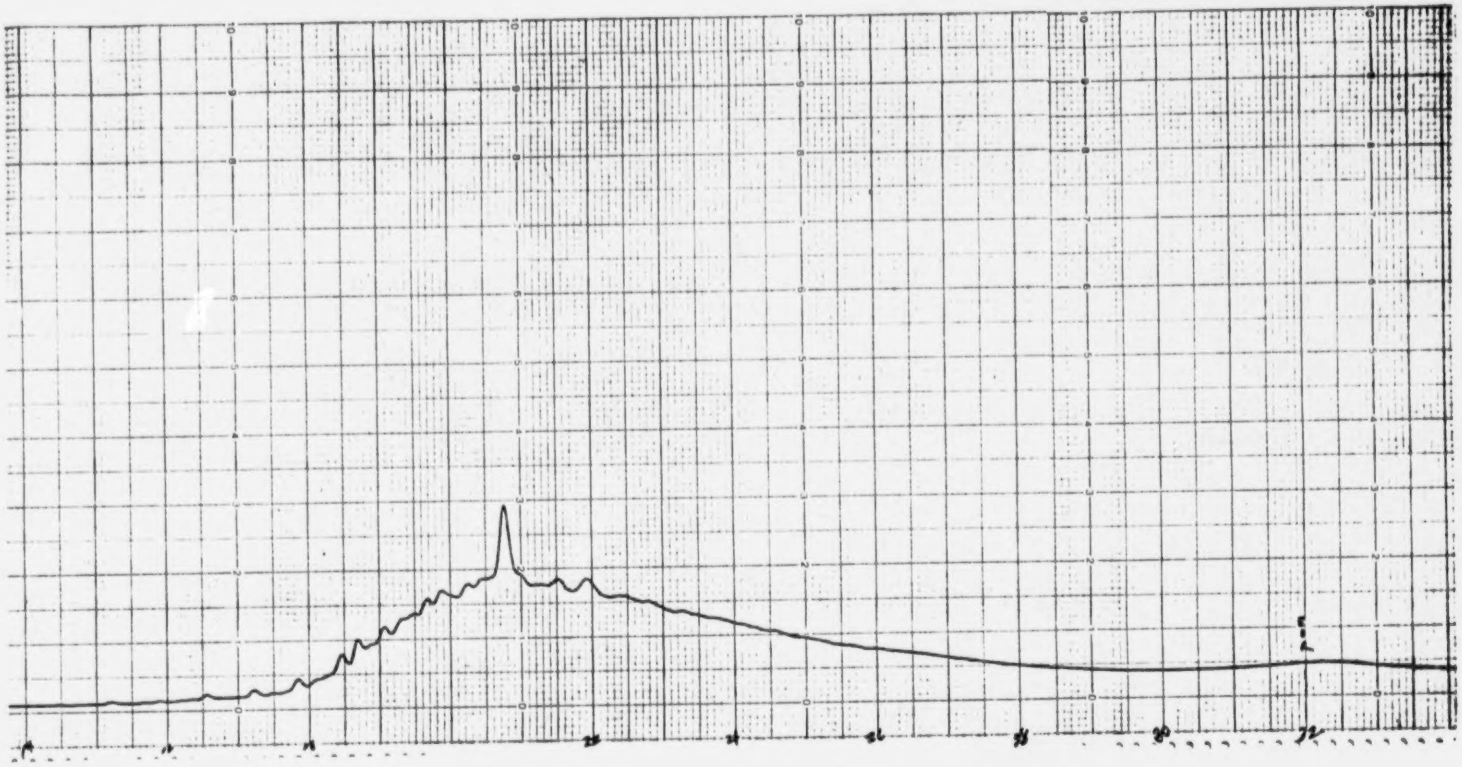

Figure G-25. Chromatogram of organic solubles from particulate matter, Volkswagen Rabbit Diesel operated on EM-240-F fuel (repeat)

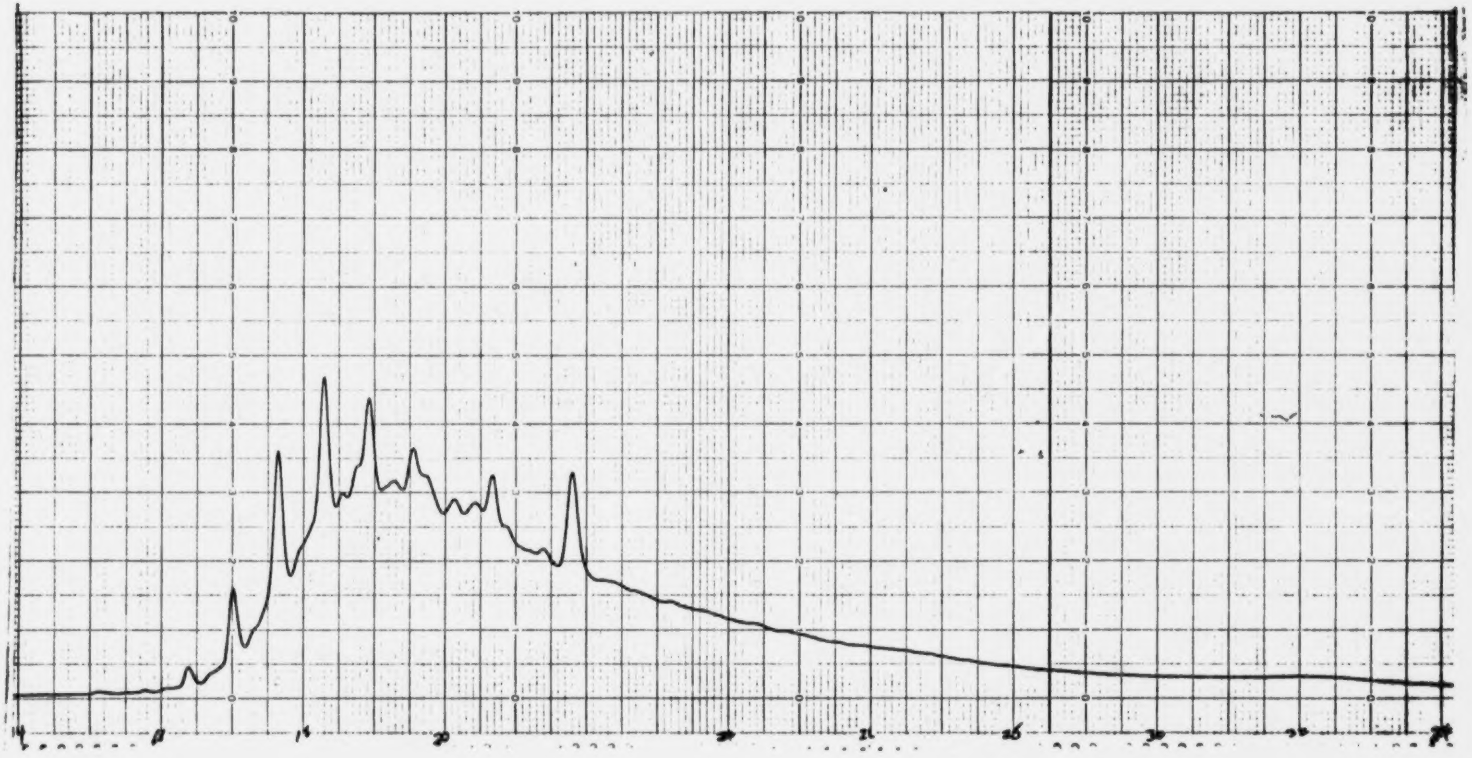

Figure G-26. Chromatogram of organic solubles from particulate matter, Volkswagen Rabbit Diesel operated on EM-241-F fuel

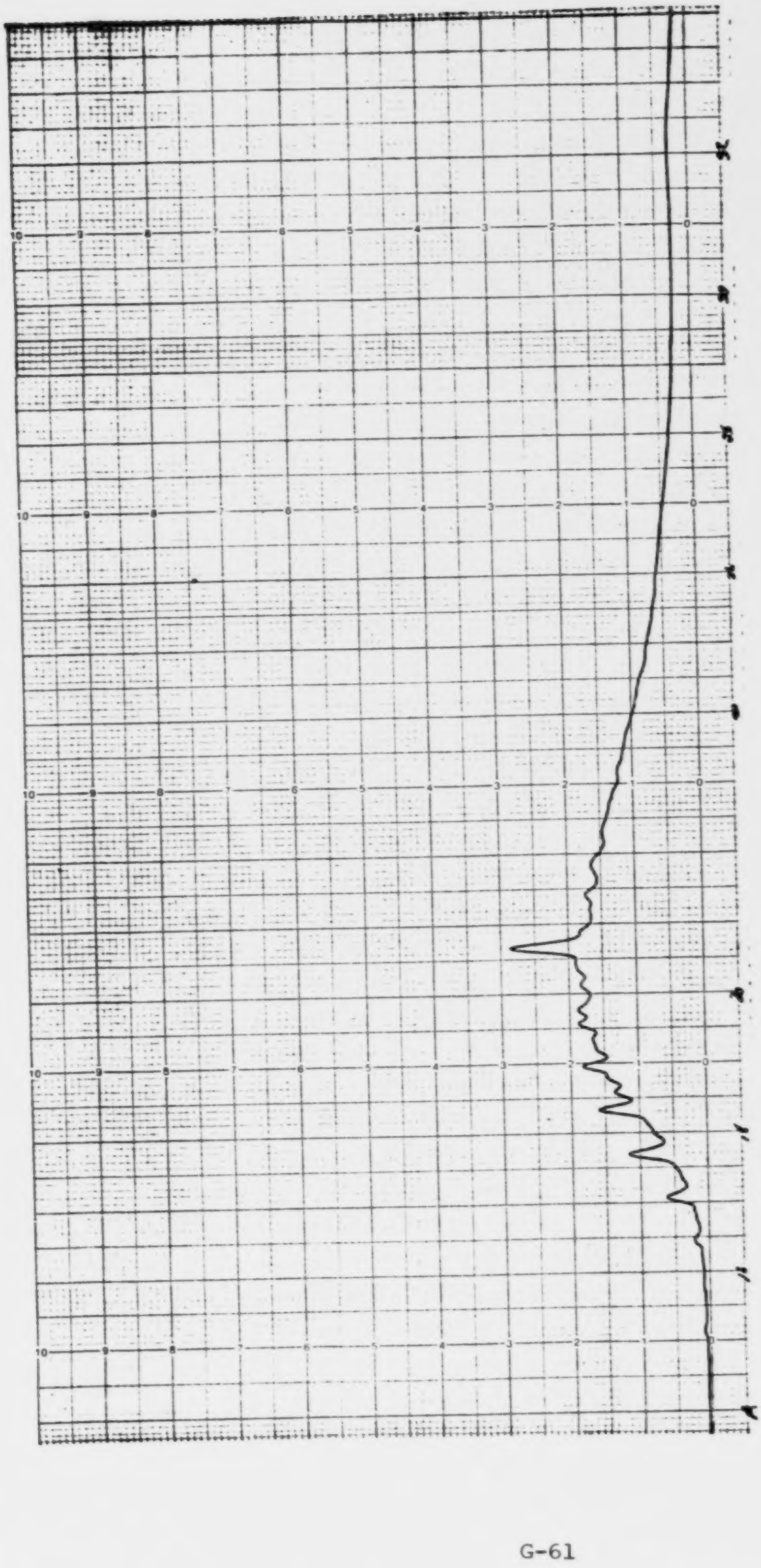

Figure G-27. Chromatogram of organic solubles from particulate matter,

Volkswagen Rabbit Diesel operated on EM-242-F fuel

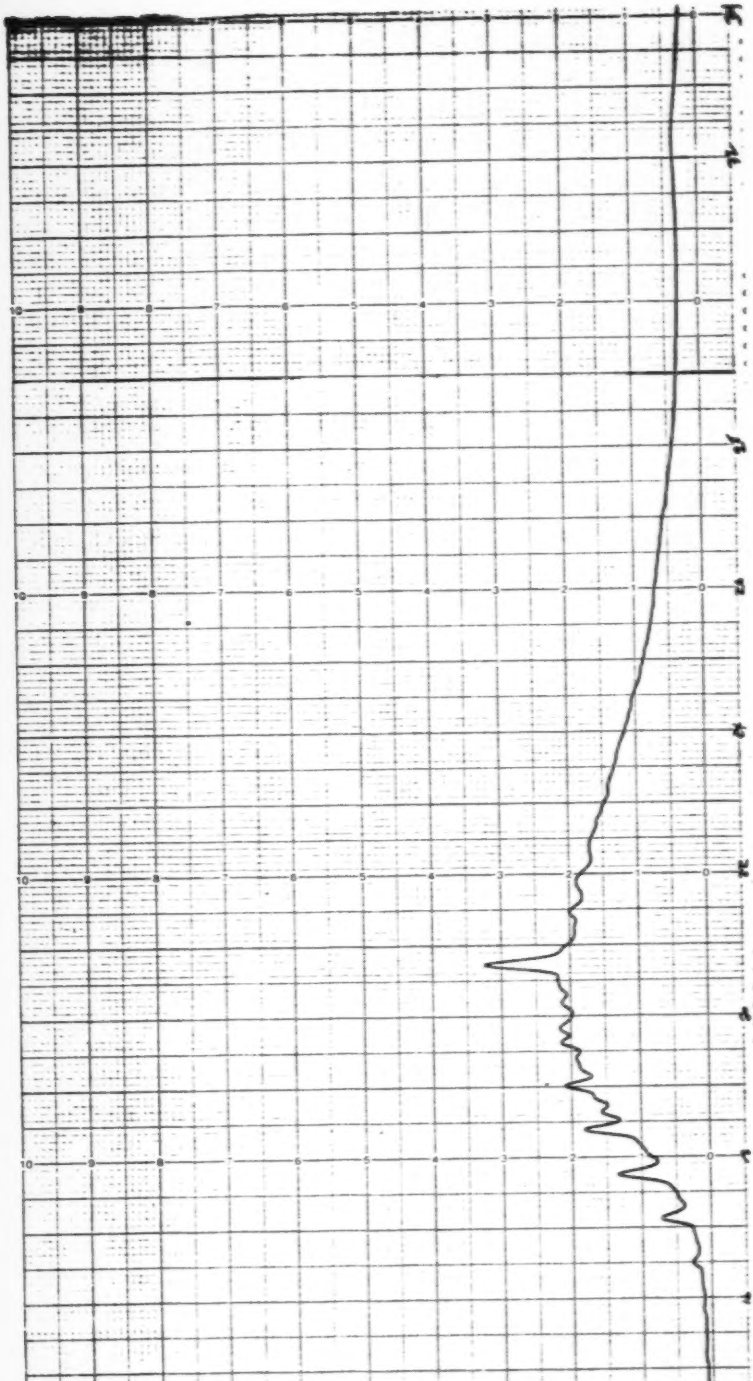

Figure G-28. Chromatogram of organic solubles from particulate matter, Volkswagen Rabbit Diesel operated on EM-242-F fuel (repeat)

MERCEDES 240D PARTICULATE - FUEL SPECIFIC BASIS

Fuel	Operating Schedule	VAR. 4 Total Particulate g/kg fuel	VAR. 7 carbon mg/kg fuel	VAR. 8 hydrogen mg/kg fuel	VAR. 9 nitrogen mg/kg fuel	VAR. 10 sulfur mg/kg fuel	VAR.11 sulfate mg/kg fuel	VAR. 12 BaP µg/kg fuel	VAR. 31 o-cresol[a] mg/kg fuel	VAR. 32 p-cresol mg/kg fuel	VAR. 33 2,4-xylenol[b] mg/kg fuel	VAR. 34 2,3-xylenol[c] mg/kg fuel
EM-238-F	FTP 3-Bag	4.59	3430.	130.	15.8	48.8	114.	5.39				
	FTPC	4.49	3460.	130.	18.0	52.3	117.	5.09				
	FTPH	4.85	3550.	136.	14.6	47.9	117.	5.84				
	CFDS	4.39	3180.	114.	17.5	69.0	168.	2.19				
	FET	3.90	2850.	89.8	11.7	55.2	239.	1.40				
	NYCC	6.08	4630.	158.	30.4	32.2	116.	17.0				
	Idle	5.74	3610	144.	23.0	59.6	150.	23.0	0.0	0.0	0.0	0.0
	50 KPH	3.83	2980.	103.	7.65	30.6	86.7	3.57	0.740	0.383	0.0	0.0
	85 KPH	3.60	2660.	108.	14.4	68.0	176.	1.45	0.129	0.110	0.0	0.0
EM-239-F	FTP 3-Bag	4.33	3200.	163.	40.9	38.4	103.	6.34				
	FTPC	4.18	3070.	151.	41.8	38.0	109.	7.08				
	FTPH	4.54	3380.	177.	40.9	39.4	101.	5.84				
	CFDS	3.70	2720.	118.	104.	42.6	157.	3.11				
	FET	3.48	2560.	101.	111.	34.5	151.	1.22				
	NYCC	4.70	3960.	225.	56.3	21.6	56.5	22.4				
	Idle	6.48	5270.	291.	142.	30.8	88.2	38.9	2.05	0.0	0.0	0.0
	50 KPH	3.40	2970.	109.	64.6	18.2	47.9	2.87	0.0	0.0	0.0	0.0
	85 KPH	2.98	2260.	86.3	23.8	43.4	141.	0.596	0.199	0.217	0.0	0.0
EM-240-F	FTP 3-Bag	3.43	2620.	92.3	17.4	11.2	30.9	4.71				
	FTPC	3.50	2790.	98.0	13.9	12.3	39.0	5.30				
	FTPH	3.44	2550.	89.5	20.7	10.6	24.7	4.32				
	CFDS	2.74	2030.	63.0	24.6	13.7	39.6	2.80				
	FET	2.48	2230.	74.3	52.0	13.8	42.5	2.83				
	NYCC	2.62	2100.	70.7	65.4	4.96	12.4	6.20				
	Idle	2.72	2120.	114.	10.9	8.51	12.7	16.7	0.0	0.0	0.0	0.0
	50 KPH	3.19	2830.	35.0	25.5	5.32	14.3	1.34	0.0	0.0	0.0	0.0
	85 KPH	2.50	1890.	62.4	20.0	7.34	27.5	2.57	0.385	0.129	0.0	0.0
EM-241-F	FTP 3-Bag	4.71	3580.	149.	18.8	47.4	117.	7.68				
	FTPC	4.87	3660.	141.	19.4	47.7	114.	8.82				
	FTPH	4.68	3600.	160.	18.7	48.4	122.	6.93				
	CFDS	3.80	2840.	106.	19.1	65.0	177.	2.36				
	FET	4.26	3090.	95.0	14.5	51.2	198.	1.42				
	NYCC	6.09	4650.	122.	24.4	41.5	55.8	30.2				
	Idle	7.09	4730.	192.	42.6	55.0	110.	97.5	0.0	0.0	0.0	0.0
	50 KPH	3.55	3050.	181.	17.7	33.1	66.2	3.55	0.0	0.0	0.0	0.0
	85 KPH	3.91	2950.	133.	15.6	55.9	137.	0.593	0.0	0.0	0.0	0.0
EM-242-F	FTP 3-Bag	3.75	2770.	98.9	15.0	47.5	112.	2.95				
	FTPC	3.66	2790.	98.8	14.7	50.2	90.6	2.82				
	FTPH	3.95	2860.	103.	15.8	47.0	134.	3.18				
	CFDS	3.57	2560.	89.2	14.3	86.1	193.	2.28				
	FET	3.36	2380.	94.2	16.8	63.1	137.	2.79				
	NYCC	5.17	3890.	134.	36.2	40.4	78.0	6.88				
	Idle	5.75	3650.	144.	40.3	59.4	121.	8.70	0.0	0.0	0.0	0.0
	50 KPH	3.40	2040.	112.	23.8	31.1	64.8	9.86	0.0	0.0	0.0	0.0
	85 KPH	3.94	3030.	102.	15.8	82.8	170.	0.565	0.020	0.081	0.0	0.0

[a] plus salicylaldehyde
[b] plus 2,5-xylenol
[c] plus 3,5-xylenol

VW RABBIT DIESEL PARTICULATE - FUEL SPECIFIC BASIS

Fuel	Operating Schedule	VAR. 4 Total Particulate g/kg fuel	VAR. 7 carbon mg/kg fuel	VAR. 8 hydrogen mg/kg fuel	VAR. 9 nitrogen mg/kg fuel	VAR. 10 sulfur mg/kg fuel	VAR. 11 sulfate mg/kg fuel	VAR. 12 BaP µg/kg fuel	VAR. 31 o-cresol[a] mg/kg fuel	VAR. 32 p-cresol mg/kg fuel	VAR. 33 2,4-xylenol[b] mg/kg fuel	VAR. 34 2,3-xylenol[c] mg/kg fuel
EM-238-F	FTP 3-Bag	4.66	3270.	184.	18.6	43.3	131.	23.4				
	FTPC	5.01	3440.	191.	20.1	43.8	157.	37.8				
	FTPH	4.44	3180.	182.	17.8	43.5	111.	12.0				
	CFDS	5.14	3840.	226.	31.0	79.9	230.	8.99				
	FET	4.71	3290.	169.	18.8	59.9	190.	10.6				
	NYCC	5.03	2360.	160.	10.1	27.7	83.1	23.6				
	Idle	5.29	1720.	211.	63.6	49.3	121.	12.3	0.0	0.52	0.0	0.0
	50 KPH	3.10	1870.	180.	24.8	12.4	48.2	11.7	0.0	0.0	0.0	0.0
	85 KPH	4.44	3350.	173.	22.2	63.8	173.	6.65	0.37	0.24	0.0	0.0
EM-239-F	FTP 3-Bag	4.61	3190.	194.	43.9	33.0	109.	28.2				
	FTPC	5.01	3350.	190.	40.1	38.1	124.	46.1				
	FTPH	4.42	3170.	203.	48.5	29.6	100.	13.7				
	CFDS	4.67	3370.	126.	51.3	48.2	171.	9.39				
	FET	3.75	2830.	172.	33.8	31.5	115.	6.55				
	NYCC	5.30	3150.	403.	90.2	18.0	59.4	22.1				
	Idle	5.97	2110.	490.	110.	39.4	200.	14.9	0.0	0.56	0.0	0.0
	50 KPH	2.27	1390.	184.	29.5	8.01	30.0	11.0	0.0	0.17	0.0	0.0
	85 KPH	4.00	3330.	180.	36.0	40.6	135.	5.95	0.0	0.0	0.0	0.0
EM-240-F	FTP 3-Bag	3.85	2650.	128.	9.63	14.8	51.1	25.6				
	FTPC	4.32	2870.	138.	9.51	20.7	74.4	41.4				
	FTPH	3.44	2470.	120.	9.74	9.96	31.7	12.7				
	CFDS	3.80	2570.	156.	10.7	11.5	58.6	30.6				
	FET	3.76	2510.	158.	8.73	9.82	27.3	23.7				
	NYCC	4.34	2340.	156.	16.2	4.12	61.7	5.15				
	Idle	2.02	820.	58.5	10.9	4.08	32.6	0.0	0.0	0.0	0.0	0.0
	50 KPH	1.72	1040.	83.9	6.57	1.09	11.7	0.69	0.18	0.36	0.0	0.0
	85 KPH	2.86	2230.	103.	7.22	6.66	38.9	20.5	0.08	0.33	0.0	0.0
EM-241-F	FTP 3-Bag	7.06	4850.	351.	30.7	36.5	151.	68.5				
	FTPC	10.2	7170.	538.	40.7	43.2	198.	126.				
	FTPH	4.75	3120.	210.	23.8	32.9	105.	22.6				
	CFDS	5.14	3590.	200.	25.7	53.2	185.	16.9				
	FET	4.38	3150.	160.	17.5	37.8	126.	10.3				
	NYCC	5.66	2480.	140.	51.0	17.6	95.6	18.9				
	Idle	6.26	2360.	280.	43.9	37.5	242.	10.6	0.0	0.0	0.15	0.0
	50 KPH	6.22	3500.	480.	18.7	11.4	34.7	3.03	0.0	0.0	0.08	0.0
	85 KPH	4.87	3660.	170.	29.1	33.5	126.	8.24	0.33	0.77	0.0	0.82
EM-242-F	FTP 3-Bag	3.96	2820.	157.	23.9	44.3	81.7	21.4				
	FTPC	4.38	3030.	167.	21.8	47.6	103.	35.7				
	FTPH	3.56	2600.	146.	25.0	40.9	63.4	9.82				
	CFDS	3.69	2550.	151.	18.4	66.2	158.	7.09				
	FET	4.47	3170.	183.	22.4	33.2	192.	10.2				
	NYCC	5.56	2890.	256.	44.6	18.0	67.8	19.4				
	Idle	5.85	1560.	298.	81.9	39.0	150.	9.75	0.0	0.0	0.0	0.0
	50 KPH	1.77	1110.	86.7	21.2	9.52	40.8	6.12	0.0	0.20	0.0	0.0
	85 KPH	4.35	3340.	180.	17.4	61.0	122.	2.66	0.27	0.21	0.0	0.0

[a] plus salicylaldehyde
[b] plus 2,5-xylenol
plus 3,5-xylenol

APPENDIX H

DATA RELATED TO STATISTICAL ANALYSIS

COMPLETE FUEL-FUEL PAIRWISE CORRELATIONS, 5 FUELS

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                                                                              78/06/29.    07.47.05.     PAGE    4
FILE   MERCEDES (CREATION DATE =  78/06/29.)   AND VOLKSWAGEN FUEL ANALYSIS
- - - - - - - - - - - - - P E A R S O N   C O R R E L A T I O N   C O E F F I C I E N T S - - - - - - - - - - - - -
               V59       V60       V61       V62       V63       V65       V66       V67       V68       V69

V59          1.0000     .8051    -.4555     .6425     .7794     .8861     .8839     .9174     .8981     .8823

V60           .8051    1.0000     .1532     .8420     .9717     .9763     .9751     .9616     .9726     .9830

V61          -.4555     .1532    1.0000     .1130     .1391     .0004    -.0038    -.0795    -.0237     .0165

V62           .6425     .8420     .1130    1.0000     .9156     .7421     .7497     .7397     .7388     .7665

V63           .7794     .9717     .1391     .9156    1.0000     .9187     .9121     .9023     .9189     .9411

V65           .8861     .9763     .0004     .7421     .9187    1.0000     .9984     .9960     .9994     .9972

V66           .8839     .9751    -.0038     .7497     .9121     .9984    1.0000     .9970     .9965     .9926

V67           .9174     .9616    -.0795     .7397     .9023     .9960     .9970    1.0000     .9963     .9901

V68           .8981     .9726    -.0237     .7388     .9189     .9994     .9965     .9963    1.0000     .9978

V69           .8823     .9830     .0165     .7665     .9411     .9972     .9926     .9901     .9978    1.0000

V70           .8773     .9878     .0264     .7995     .9595     .9915     .9863     .9834     .9925     .9981

V71           .8859     .9832     .0047     .8056     .9634     .9867     .9801     .9794     .9890     .9956

V72           .8831     .9756     .0093     .7624     .9477     .9880     .9788     .9783     .9909     .9963

V73           .8431     .9904     .0847     .8281     .9790     .9760     .9683     .9620     .9769     .9888

V74           .8240     .9863     .0916     .8936     .9952     .9519     .9472     .9401     .9520     .9680

V75           .8116     .9832     .1051     .9032     .9975     .9429     .9381     .9301     .9429     .9606

V76           .4952     .6413     .1623     .6289     .7661     .5714     .5323     .5314     .5858     .6300

V77           .7863     .9526     .1163     .8661     .9896     .9094     .8950     .8890     .9133     .9372

V78           .8989     .9690    -.0304     .7294     .9095     .9994     .9978     .9977     .9996     .9956

V79           .8911     .8859    -.1340     .5799     .7758     .9597     .9656     .9705     .9581     .9375

V80           .9025     .9687    -.0423     .7411     .9081     .9985     .9990     .9993     .9980     .9931

V81           .8817     .9864     .0183     .7868     .9508     .9953     .9910     .9883     .9958     .9995

V82           .8705     .9877     .0416     .7820     .9521     .9942     .9888     .9847     .9945     .9993

V83           .8598     .9865     .0616     .7738     .9526     .9912     .9841     .9789     .9918     .9979

V84           .8320     .9852     .1063     .7899     .9667     .9763     .9660     .9585     .9774     .9849

V85           .8249     .9881     .1214     .7923     .9670     .9772     .9677     .9588     .9775     .9891
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COMPLETE FUEL-FUEL PAIRWISE CORRELATIONS, 5 FUELS (Cont'd.)

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                                                                  78/06/29.    07.47.05.     PAGE    5

FILE   MERCEDES (CREATION DATE =  78/06/29.)   AND VOLKSWAGEN FUEL ANALYSIS
- - - - - - - - - - - - - - P E A R S O N   C O R R E L A T I O N   C O E F F I C I E N T S - - - - - - - - - - - - -
               V59        V60        V61        V62        V63        V65        V66        V67        V68        V69

V86           .8240      .9924      .1250      .8060      .9707      .9788      .9709      .9613      .9784      .9898

V87           .8060      .9931      .1531      .8211      .9773      .9707      .9628      .9512      .9698      .9837

V88           .7716      .9582      .1234      .9373      .9980      .8983      .8928      .8942      .8988      .9225

V89           .9089      .4889     -.7850      .3930      .4747      .6176      .6189      .6773      .6369      .6063

V90          -.9411     -.5668      .7245     -.4840     -.5670     -.6774     -.6762     -.7308     -.6965     -.6725

V91           .5950      .0925     -.7724     -.2215      .0163      .2949      .2806      .3410      .3178      .2726

V92           .7877      .9242      .0811      .8266      .9703      .8886      .8691      .8673      .8956      .9202

V93           .8583      .4839     -.7296      .5359      .5536      .5563      .5492      .6074      .5796      .5700

V94          -.7837     -.9239     -.1108     -.5936     -.8109     -.9634     -.9661     -.9530     -.9569     -.9465

V95          -.7985     -.3948      .7682     -.4866     -.4800     -.4651     -.4575     -.5192     -.4901     -.4813

V96           .9399      .6853     -.5790      .7091      .7181      .7385      .7422      .7851      .7530      .7424
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COMPLETE FUEL-FUEL PAIRWISE CORRELATIONS, 5 FUELS (Cont'd.)

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                                                                        78/06/29.    07.47.05.      PAGE     6

FILE   MERCEDES (CREATION DATE =  78/06/29.)   AND VOLKSWAGEN FUEL ANALYSIS

- - - - - - - - - - - - - P E A R S O N   C O R R E L A T I O N   C O E F F I C I E N T S - - - - - - - - - - - -
              V70       V71       V72       V73       V74       V75       V76       V77       V78       V79

V59          .8773     .8859     .8831     .8431     .8240     .8116     .4952     .7863     .8989     .8911

V60          .9878     .9832     .9756     .9904     .9863     .9832     .6413     .9526     .9690     .8859

V61          .0264     .0047     .0093     .0847     .0916     .1051     .1623     .1163    -.0304    -.1340

V62          .7995     .8056     .7624     .8281     .8936     .9032     .6289     .8661     .7294     .5799

V63          .9595     .9634     .9477     .9790     .9952     .9975     .7661     .9896     .9095     .7758

V65          .9915     .9867     .9880     .9760     .9519     .9429     .5714     .9094     .9994     .9597

V66          .9863     .9801     .9788     .9683     .9472     .9381     .5323     .8950     .9978     .9656

V67          .9834     .9794     .9783     .9620     .9401     .9301     .5314     .8890     .9977     .9705

V68          .9925     .9890     .9909     .9769     .9520     .9429     .5858     .9133     .9996     .9581

V69          .9981     .9956     .9963     .9888     .9680     .9606     .6300     .9372     .9956     .9375

V70         1.0000     .9991     .9968     .9955     .9812     .9754     .6629     .9554     .9889     .9166

V71          .9991    1.0000     .9973     .9960     .9832     .9778     .6854     .9627     .9845     .9063

V72          .9968     .9973    1.0000     .9921     .9702     .9635     .6896     .9546     .9866     .9139

V73          .9955     .9960     .9921    1.0000     .9916     .9883     .7180     .9774     .9709     .8758

V74          .9812     .9832     .9702     .9916    1.0000     .9996     .7233     .9832     .9449     .8334

V75          .9754     .9778     .9635     .9883     .9996    1.0000     .7323     .9849     .9353     .8178

V76          .6629     .6854     .6896     .7180     .7233     .7323    1.0000     .8366     .5621     .3470

V77          .9554     .9627     .9546     .9774     .9832     .9849     .8366    1.0000     .9016     .7586

V78          .9889     .9845     .9866     .9709     .9449     .9353     .5621     .9016    1.0000     .9657

V79          .9166     .9063     .9139     .8758     .8334     .8178     .3470     .7586     .9657    1.0000

V80          .9866     .9817     .9813     .9671     .9444     .9348     .5397     .8949     .9991     .9685

V81          .9995     .9976     .9961     .9921     .9754     .9688     .6404     .9452     .9932     .9291

V82          .9993     .9972     .9970     .9936     .9755     .9691     .6517     .9485     .9915     .9242

V83          .9982     .9963     .9978     .9945     .9744     .9683     .6704     .9528     .9881     .9162

V84          .9932     .9930     .9942     .9974     .9808     .9765     .7264     .9722     .9713     .8790

V85          .9931     .9921     .9929     .9973     .9811     .9770     .7173     .9700     .9718     .8806
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COMPLETE FUEL-FUEL PAIRWISE CORRELATIONS, 5 FUELS (Cont'd.)

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                                                                   78/06/29.    07.47.05.     PAGE    7

FILE   MERCEDES (CREATION DATE =  78/06/29.)   AND VOLKSWAGEN FUEL ANALYSIS

- - - - - - - - - - - - P E A R S O N   C O R R E L A T I O N   C O E F F I C I E N T S - - - - - - - - - - - -
                V70       V71       V72       V73       V74       V75       V76       V77       V78       V79

V86            .9942     .9926     .9915     .9982     .9848     .9809     .7047     .9693     .9730     .8827

V87            .9900     .9886     .9859     .9975     .9878     .9850     .7174     .9745     .9637     .8653

V88            .9440     .9493     .9295     .9657     .9897     .9933     .7663     .9842     .8888     .7485

V89            .5976     .6132     .6088     .5456     .5290     .5138     .2565     .4883     .6410     .6872

V90           -.6688    -.6856    -.6791    -.6253    -.6139    -.6008    -.3584    -.5819    -.6981    -.7164

V91            .2385     .2495     .2875     .1711     .0877     .0640     .0237     .0859     .3257     .4516

V92            .9388     .9491     .9455     .9623     .9625     .9638     .8769     .9948     .8823     .7336

V93            .5829     .6096     .5930     .5607     .5754     .5693     .4739     .5781     .5743     .5342

V94           -.9276    -.9125    -.9241    -.9015    -.8568    -.8442    -.4085    -.7941    -.9622    -.9691

V95           -.4969    -.5262    -.5077    -.4769    -.4972    -.4924    -.4437    -.5072    -.4839    -.4416

V96            .7523     .7690     .7452     .7267     .7468     .7403     .4564     .7091     .7513     .7185
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COMPLETE FUEL-FUEL PAIRWISE CORRELATIONS, 5 FUELS (Cont'd.)

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                                                          78/06/29.    07.47.05.     PAGE    8
FILE   MERCEDES (CREATION DATE =  78/06/29.)   AND VOLKSWAGEN FUEL ANALYSIS

- - - - - - - - - - - - - P E A R S O N   C O R R E L A T I O N   C O E F F I C I E N T S - - - - - - - - - - - -
              V80        V81        V82        V83        V84        V85        V86        V87        V88        V89

V59          .9025      .8817      .8705      .8598      .8320      .8249      .8240      .8060      .7716      .9089

V60          .9687      .9864      .9877      .9865      .9852      .9881      .9924      .9931      .9582      .4889

V61         -.0423      .0183      .0416      .0616      .1063      .1214      .1250      .1531      .1234     -.7850

V62          .7411      .7868      .7820      .7738      .7899      .7923      .8060      .8211      .9373      .3930

V63          .9081      .9508      .9521      .9526      .9667      .9670      .9707      .9773      .9980      .4747

V65          .9985      .9953      .9942      .9912      .9763      .9772      .9788      .9707      .8983      .6176

V66          .9990      .9910      .9888      .9841      .9660      .9677      .9709      .9628      .8928      .6189

V67          .9993      .9883      .9847      .9789      .9585      .9588      .9613      .9512      .8842      .6773

V68          .9980      .9958      .9945      .9918      .9774      .9775      .9784      .9698      .8988      .6369

V69          .9931      .9995      .9993      .9979      .9889      .9891      .9898      .9837      .9225      .6063

V70          .9866      .9995      .9993      .9982      .9932      .9931      .9942      .9900      .9440      .5976

V71          .9817      .9976      .9972      .9963      .9930      .9921      .9926      .9886      .9493      .6132

V72          .9813      .9961      .9970      .9978      .9942      .9929      .9915      .9859      .9295      .6088

V73          .9671      .9921      .9936      .9945      .9974      .9973      .9982      .9975      .9657      .5456

V74          .9444      .9754      .9755      .9744      .9808      .9811      .9848      .9878      .9897      .5290

V75          .9348      .9688      .9691      .9683      .9765      .9770      .9809      .9850      .9933      .5138

V76          .5397      .6404      .6517      .6704      .7264      .7173      .7047      .7174      .7663      .2565

V77          .8949      .9452      .9485      .9528      .9722      .9700      .9693      .9745      .9842      .4883

V78          .9991      .9932      .9915      .9881      .9713      .9718      .9730      .9637      .8888      .6410

V79          .9685      .9291      .9242      .9162      .8790      .8806      .8827      .8653      .7485      .6872

V80         1.0000      .9912      .9886      .9837      .9650      .9658      .9682      .9589      .8890      .6495

V81          .9912     1.0000      .9996      .9979      .9903      .9905      .9917      .9865      .9341      .6049

V82          .9886      .9996     1.0000      .9993      .9934      .9937      .9944      .9897      .9345      .5860

V83          .9837      .9979      .9993     1.0000      .9963      .9964      .9963      .9921      .9339      .5688

V84          .9650      .9903      .9934      .9963     1.0000      .9998      .9988      .9972      .9494      .5274

V85          .9658      .9905      .9937      .9964      .9998     1.0000      .9995      .9983      .9495      .5156
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COMPLETE FUEL-FUEL PAIRWISE CORRELATIONS, 5 FUELS (Cont'd.)

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                                                                        78/06/29.    07.47.05.     PAGE    9

FILE   MERCEDES (CREATION DATE =  78/06/29.)   AND VOLKSWAGEN FUEL ANALYSIS

- - - - - - - - - - - - - P E A R S O N   C O R R E L A T I O N   C O E F F I C I E N T S - - - - - - - - - - - - -
                 V80         V81         V82         V83         V84         V85         V86         V87         V88         V89

V86            .9682       .9917       .9944       .9963       .9988       .9995      1.0000       .9992       .9543       .5137

V87            .9589       .9865       .9897       .9921       .9972       .9483       .9992      1.0000       .9622       .4878

V88            .8890       .9341       .9345       .9339       .9494       .9495       .9543       .9622      1.0000       .4764

V89            .6495       .6049       .5860       .5688       .5274       .5156       .5137       .4878       .4764      1.0000

V90          -.7052      -.6733      -.6558      -.6404      -.6063      -.5946      -.5928      -.5701      -.5699      -.9931

V91            .3174       .2536       .2433       .2384       .1927       .1784       .1618       .1244      -.0094       .7748

V92            .8723       .9275       .9316       .9381       .9608       .9566       .9529       .9571       .9638       .5045

V93            .5804       .5785       .5613       .5480       .5332       .5187       .5163       .5014       .5712       .9344

V94          -.9604      -.9378      -.4394      -.9375      -.9126      -.9174      -.9191      -.9080      -.7781      -.4975

V95          -.4905      -.4911      -.4731      -.4596      -.4471      -.4315      -.4289      -.4147      -.5020      -.9103

V96            .7632       .7513       .7341       .7173       .6945       .6857       .6900       .6773       .7321       .9241
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COMPLETE FUEL-FUEL PAIRWISE CORRELATIONS, 5 FUELS (Cont'd.)

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                                                                    78/06/29.    07.47.05.     PAGE   10

FILE   MERCEDES (CREATION DATE =  78/06/29.)   AND VOLKSWAGEN FUEL ANALYSIS

- - - - - - - - - - - - - P E A R S O N   C O R R E L A T I O N   C O E F F I C I E N T S - - - - - - - - - - - - -
             V90        V91        V92        V93        V94        V95        V96

V59        -.9411      .5950      .7877      .8583     -.7837     -.7985      .9399

V60        -.5668      .0925      .9242      .4839     -.9239     -.3948      .6853

V61         .7245     -.7724      .0811     -.7296     -.1108      .7682     -.5790

V62        -.4840     -.2215      .8266      .5359     -.5936     -.4866      .7091

V63        -.5670      .0163      .9703      .5536     -.8109     -.4800      .7181

V65        -.6774      .2949      .8886      .5563     -.9634     -.4651      .7385

V66        -.6762      .2806      .8691      .5492     -.9661     -.4575      .7422

V67        -.7308      .3410      .8673      .6074     -.9530     -.5192      .7851

V68        -.6965      .3178      .8956      .5796     -.9569     -.4901      .7530

V69        -.6725      .2726      .9202      .5700     -.9465     -.4813      .7424

V70        -.6688      .2385      .9388      .5829     -.9276     -.4969      .7523

V71        -.6856      .2495      .9491      .6096     -.9125     -.5262      .7690

V72        -.6791      .2875      .9455      .5930     -.9241     -.5077      .7452

V73        -.6253      .1711      .9623      .5607     -.9015     -.4769      .7267

V74        -.6139      .0877      .9625      .5754     -.8568     -.4972      .7468

V75        -.6008      .0640      .9638      .5693     -.8442     -.4924      .7403

V76        -.3584      .0237      .8769      .4739     -.4085     -.4437      .4564

V77        -.5819      .0859      .9948      .5781     -.7941     -.5072      .7091

V78        -.6981      .3257      .8823      .5743     -.9622     -.4839      .7513

V79        -.7164      .4516      .7336      .5342     -.9691     -.4416      .7185

V80        -.7052      .3174      .8723      .5804     -.9604     -.4905      .7632

V81        -.6733      .2536      .9275      .5785     -.9378     -.4911      .7513

V82        -.6558      .2433      .9316      .5613     -.9394     -.4731      .7341

V83        -.6404      .2384      .9381      .5480     -.9375     -.4596      .7173

V84        -.6063      .1927      .9608      .5332     -.9126     -.4471      .6945

V85        -.5946      .1784      .9566      .5187     -.9174     -.4315      .6857
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COMPLETE FUEL-FUEL PAIRWISE CORRELATIONS, 5 FUELS (Cont'd.)

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                                                                        78/06/29.     07.47.05.     PAGE   11

FILE   MERCEDES (CREATION DATE =  78/06/29.)    AND VOLKSWAGEN FUEL ANALYSIS

- - - - - - - - - - - - - P E A R S O N   C O R R E L A T I O N   C O E F F I C I E N T S - - - - - - - - - - - - -
              V90        V91        V92        V93        V94        V95        V96

V86         -.5928      .1618      .9529      .5163     -.9191     -.4289      .6900

V87         -.5701      .1244      .9571      .5014     -.9080     -.4147      .6773

V88         -.5699     -.0094      .9638      .5712     -.7781     -.5020      .7321

V89         -.9931      .7748      .5045      .9344     -.4975     -.9103      .9241

V90         1.0000     -.7230     -.5977     -.9558      .5421      .9273     -.9562

V91         -.7230     1.0000      .1386      .6049     -.2834     -.5937      .4894

V92         -.5977      .1386     1.0000      .6046     -.7643     -.5381      .7074

V93         -.9558      .6049      .6046     1.0000     -.3587     -.9942      .9504

V94          .5421     -.2834     -.7643     -.3587     1.0000      .2564     -.5724

V95          .9273     -.5937     -.5381     -.9942      .2564     1.0000     -.9182

V96         -.9562      .4894      .7074      .9504     -.5724     -.9182     1.0000

    A VALUE OF 99.0000 IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.
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LATENT ROOT/VECTOR ANALYSIS OF FUEL VARIABLES
61, 91, 92, 93 and 94 (CETANE, N, S, AROMATICS, AND OLEFINS)

```
                          LATENT ROOTS OF X PRIME X
                            (IN DESCENDING ORDER)

 .268996123E+01  .169968299E+01  .494917762E+00  .115438020E+00 -.471207469E-15



                          LATENT VECTORS OF X PRIME X
                   (IN CORRESPONDENCE TO THE LATENT ROOTS ABOVE)

                                                   V(5)
-.42592704   .48612988   .37790573   .56624212  -.34470425

                                                   V(4)
 .53596843  -.30020215   .56201831  -.04998777  -.55159147

                                                   V(3)
-.11424390  -.59844200   .33048243   .51457259   .50478897

                                                   V(2)
 .38700726   .54173423   .46457864  -.13878427   .56714639

                                                   V(1)
 .60704012   .14814723  -.46504917   .62675758  -.02142190
```

INVERSE OF MATRIX, FUEL VARIABLES 61, 91, 92, 93, and 94
(CETANE, N, S, AROMATICS, AND OLEFINS)

```
                                      INVERSE OF X PRIME X

                                              ROW(1)
-.782028586E+15 -.190852896E+15  .599106605E+15 -.807429891E+15  .275970798E+14

                                              ROW(2)
-.190852896E+15 -.465773610E+14  .146211062E+15 -.197052046E+15  .673502566E+13

                                              ROW(3)
 .599106605E+15  .146211062E+15 -.458971361E+15  .618566366E+15 -.211419289E+14

                                              ROW(4)
-.807429891E+15 -.197052046E+15  .618566366E+15 -.833656264E+15  .284934689E+14

                                              ROW(5)
 .275970798E+14  .673502566E+13 -.211419289E+14  .284934689E+14 -.973875928E+12
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FACTOR ANALYSIS OF ALL FUEL VARIABLES EXCEPT D86 BOILING RANGE

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                                                                         78/04/03.    06.48.15.     PAGE    7
FILE   MERCEDES (CREATION DATE =  78/04/03.)   AND VOLKSWAGEN FUEL ANALYSIS
SUBFILE   M          V


VARIABLE   EST COMMUNALITY                  FACTOR        EIGENVALUE   PCT OF VAR   CUM PCT

V59              .94493                        1          18.49924        74.0        74.0
V60              .99307                        2           4.40900        17.6        91.6
V61              .78496                        3           1.45439         5.8        97.5
V62              .93735                        4            .63737         2.5       100.0
V76              .87690                        5            .00000          .0       100.0
V77              .99481                        6            .00000          .0       100.0
V78              .99912                        7            .00000          .0       100.0
V79              .96910                        8            .00000          .0       100.0
V80              .99912                        9            .00000          .0       100.0
V81              .99957                       10            .00000          .0       100.0
V82              .99957                       11            .00000          .0       100.0
V83              .99934                       12            .00000          .0       100.0
V84              .99975                       13            .00000          .0       100.0
V85              .99975                       14            .00000          .0       100.0
V86              .99950                       15            .00000          .0       100.0
V87              .99918                       16           -.00000        -.0       100.0
V88              .98424                       17           -.00000        -.0       100.0
V89              .99309                       18           -.00000        -.0       100.0
V90              .99309                       19           -.00000        -.0       100.0
V91              .77483                       20           -.00000        -.0       100.0
V92              .99481                       21           -.00000        -.0       100.0
V93              .99421                       22           -.00000        -.0       100.0
V94              .96910                       23           -.00000        -.0       100.0
V95              .99421                       24           -.00000        -.0       100.0
V96              .95906                       25           -.00000        -.0       100.0
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FACTOR ANALYSIS OF ALL FUEL VARIABLES EXCEPT D86 BOILING RANGE (Cont'd.)

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                                                              78/04/03.    06.48.15.     PAGE    8

FILE    MERCEDES (CREATION DATE =  78/04/03.)    AND VOLKSWAGEN FUEL ANALYSIS
SUBFILE   M           V

FACTOR MATRIX USING  PRINCIPAL FACTOR WITH ITERATIONS


                  FACTOR  1    FACTOR  2    FACTOR  3

V59                 .93187      -.34552      -.08661
V60                 .95653       .27555      -.05031
V61               -.11953        .95357      -.00219
V62                 .79974       .23335       .39355
V76                 .67010       .22622       .49441
V77                 .94797       .23288       .21058
V78                 .97567       .08613      -.20473
V79                 .90265      -.02817      -.41926
V80                 .97465       .07584      -.20570
V81                 .98591       .13792      -.09840
V82                 .98249       .16034      -.09871
V83                 .97899       .17884      -.09369
V84                 .97198       .22261      -.02808
V85                 .96895       .23819      -.03705
V86                 .96930       .24334      -.03592
V87                 .96271       .27191      -.00793
V88                 .93557       .24686       .23911
V89                 .70536      -.71058      -.07265
V90               -.77180        .64070       .00435
V91                 .32450      -.73273      -.35222
V92                 .93913       .19213       .23726
V93                 .70624      -.65103       .28941
V94               -.87778       -.21352       .42221
V95               -.63015        .69886      -.34914
V96                 .84490      -.47069       .14382

ITERATIVE PROCEDURE STOPPED AFTER   1 ITERATIONS BECAUSE COMMUNALITIES EXCEED ONE.
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FACTOR ANALYSIS OF ALL FUEL VARIABLES EXCEPT D86 BOILING RANGE (Cont'd.)

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                                                                        78/04/03.    06.48.15.     PAGE    9

FILE    MERCEDES (CREATION DATE =  78/04/03.)    AND VOLKSWAGEN FUEL ANALYSIS
SUBFILE   M           V


VARIABLE        COMMUNALITY                     FACTOR         EIGENVALUE   PCT OF VAR    CUM PCT

V59                .99526                          1            18.48322       76.4          76.4
V60                .99342                          2             4.32416       17.9          94.2
V61                .92359                          3             1.39286        5.8         100.0
V62                .84892
V76                .74465
V77                .99724
V78               1.00126
V79                .99136
V80                .99801
V81               1.00073
V82               1.00074
V83                .99919
V84                .99509
V85                .99697
V86               1.00004
V87               1.00081
V88                .99340
V89               1.00774
V90               1.00620
V91                .76626
V92                .97518
V93               1.00637
V94                .99435
V95               1.00739
V96                .95609
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FACTOR ANALYSIS OF ALL FUEL VARIABLES EXCEPT D86 BOILING RANGE (Cont'd.)

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                                                                             78/04/03.    06.48.15.     PAGE   10

FILE   MERCEDES (CREATION DATE =  78/04/03.)   AND VOLKSWAGEN FUEL ANALYSIS
SUBFILE   M           V


     VARIMAX ROTATED FACTOR MATRIX
AFTER ROTATION WITH KAISER NORMALIZATION



               FACTOR  1   FACTOR  2   FACTOR  3

V59              .69156      .68233      .22678
V60              .90522      .12329      .39850
V61              .22436     -.92260      .14852
V62              .56065      .11592      .72191
V76              .40561      .07484      .75798
V77              .76565      .16839      .61859
V78              .92694      .29920      .22916
V79              .92520      .36760     -.01526
V80              .92307      .30821      .22574
V81              .90476      .25951      .33881
V82              .90964      .23757      .34183
V83              .91073      .21439      .34875
V84              .89002      .17878      .41350
V85              .89684      .16298      .40753
V86              .89836      .15841      .40975
V87              .88990      .13059      .43798
V88              .74722      .15168      .64192
V89              .37505      .92840      .07177
V90             -.42255     -.89296     -.17399
V91              .17980      .78823     -.33559
V92              .73252      .20325      .63030
V93              .23198      .88703      .40712
V94             -.98762     -.13581     -.02245
V95             -.12600     -.90299     -.41968
V96              .47322      .77104      .37092


 TRANSFORMATION MATRIX



               FACTOR  1   FACTOR  2   FACTOR  3

FACTOR  1        .82527      .39519      .40343
FACTOR  2        .33769     -.91790      .20837
FACTOR  3       -.45266      .03573      .89097

 FACTOR SCORE COEFFICIENTS ARE INDETERMINATE
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PAIRWISE CORRELATIONS FOR NINE EMISSIONS VARIABLES, MERCEDES 240D

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                                                                       78/06/30.    11.59.53.     PAGE    3

FILE   MERCEDES (CREATION DATE =  78/06/30.)   AND VOLKSWAGEN FUEL ANALYSIS

- - - - - - - - - - - - P E A R S O N   C O R R E L A T I O N   C O E F F I C I E N T S - - - - - - - - - - - -
              V4         V6        V10        V11        V12        V35        V40        V41        V42

V4          1.0000     -.4195      .8631      .8947     -.2853      .0348      .7008      .8903      .8900

V6          -.4195     1.0000     -.4576     -.4127     -.2158     -.2410     -.3017     -.2608     -.2809

V10          .8631     -.4576     1.0000      .9258     -.3267      .1593      .5748      .7353      .7814

V11          .8947     -.4127      .9258     1.0000     -.3558      .1629      .5560      .7481      .8257

V12         -.2853     -.2158     -.3267     -.3558     1.0000      .1274      .0197     -.3362     -.4210

V35          .0348     -.2410      .1593      .1629      .1274     1.0000      .0590     -.0806     -.0487

V40          .7008     -.3017      .5748      .5560      .0197      .0590     1.0000      .6113      .5459

V41          .8903     -.2608      .7353      .7481     -.3362     -.0806      .6113     1.0000      .9407

V42          .8900     -.2809      .7814      .8257     -.4210     -.0487      .5459      .9407     1.0000

     A VALUE OF 99.0000 IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.
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PAIRWISE CORRELATIONS FOR NINE EMISSIONS VARIABLES, VW RABBIT DIESEL

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                                                                                78/07/18.    08.04.35.     PAGE    3

FILE    MERCEDES (CREATION DATE =  78/07/18.)   AND VOLKSWAGEN FUEL ANALYSIS

- - - - - - - - - - - - - P E A R S O N   C O R R E L A T I O N   C O E F F I C I E N T S - - - - - - - - - - - - -
                 V4          V6         V10         V11         V12         V35         V40         V41         V42

V4           1.0000      -.2670       .7688       .8485       .4979      -.6648       .5232       .7117       .7342

V6           -.2670      1.0000      -.3755      -.3050      -.1778       .1604      -.0398      -.1544      -.2359

V10           .7688      -.3755      1.0000       .9209       .0722      -.5820       .1289       .3798       .6498

V11           .8485      -.3050       .9209      1.0000       .1907      -.5571       .2820       .4619       .6764

V12           .4979      -.1778       .0722       .1907      1.0000      -.3047       .7787       .2859       .1337

V35          -.6648       .1604      -.5820      -.5571      -.3047      1.0000      -.0475      -.3729      -.7037

V40           .5232      -.0398       .1289       .2820       .7787      -.0475      1.0000       .4281       .1271

V41           .7117      -.1544       .3798       .4619       .2859      -.3729       .4281      1.0000       .6659

V42           .7342      -.2359       .6498       .6764       .1337      -.7037       .1271       .6659      1.0000

     A VALUE OF 99.0000 IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.
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